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Symposium: Office Orthoptics by the Ophthalmologist

INTRODUCTION AND CASE SELECTION

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IN this symposium on "Office Orthoptics by the Ophthalmologist" we will consider what can be accomplished by the ophthalmologist who does not enjoy the luxury of a good orthoptist. It is apparent that the great majority of ophthalmologists in this country do not have available the services of an orthoptic technician.

Two problems challenge those of us who are concerned about the future of orthoptics. The first relates to the number of certified orthoptic technicians. In contrast to the rather rapid increase in the number of ophthalmologists who are being trained each year, the group receiving orthoptic certification remains relatively small. Unless more qualified young women are encouraged to enter the field of orthoptics, opportunities for an ophthalmologist to obtain the services of a technician will certainly diminish.

I am approached rather frequently by ophthalmologists who want to know if it is possible to get an orthoptist. This problem is not simple. A possible solution concerns each ophthalmologist whether or not he needs a technician at the moment. If he will personally sponsor well qualified girls from his area each year to study orthoptics, an ample supply of well trained, competent orthoptists will eventually be available to us all. In the meantime, this symposium is designed to help ophthalmologists bridge the gap.

The second problem, which is quite closely related, is the continuing need for publicity as to what constitutes proper orthoptics and what are the functions of the orthoptic technician. Many ophthalmologists still do not understand what is meant by orthoptics in the larger sense. In some areas orthoptics is still considered an attempt to straighten eyes by exercises alone. There are also pseudo-orthoptists who treat without qualification all types of neuromuscular defects with exercises. While most ophthalmologists readily recognize the fallacy of such ill-conceived orthoptics, they are not informed on the merits of good orthoptics.

In the broader sense, orthoptics includes all of the procedures and techniques involved in diagnosing and treating neuromuscular defects. An orthoptic technician is one with special training in the testing, evaluation and nonsurgical treatment of these defects. But whether an ophthalmologist has an orthoptist associated with him or whether he does all of his own work in ocular motility, orthoptics remains a field within ophthalmology and should not be considered as something set apart.

Any ophthalmologist, therefore, who is considering giving some basic orthoptic treatment, should realize

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Presented at the Annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Oct. 12, 1958, Chicago.

that this is merely going one step further in the management of neuromuscular anomalies, and does not mean that he must branch out into an entirely new field. Of course, a proper ophthalmologic work-up of motility problems in a systematic manner is required, but such an evaluation need not be unduly complex or time consuming. The satisfaction to the ophthalmologist and the benefits to the patient make such an approach well worth the effort.

For various reasons, most ocular motility patients are now treated by ophthalmologists who do not have available the services of an orthoptic technician. Very few ophthalmologists would want to attempt a complete orthoptic routine without the help of a technician. However, certain phases of orthoptic practice can be utilized by the ophthalmologist to reach a proper diagnosis and carry through an effective treatment; a larger number of ophthalmologists should become conversant with the basic principles of orthoptic diagnosis and treatment.

In practicing without a technician, the ophthalmologist has a limited amount of time that he may devote to orthoptics, but before considering any orthoptic treatment he must first become expert in the fundamentals of diagnosis. As Miss MacLean will tell you, effective treatment must be based on the firm foundation of a proper diagnostic evaluation. Once this has been established, the ophthalmologist may pursue therapeutic orthoptics with the assurance that his efforts are directed in the right channels.

Even when an orthoptist works directly with an ophthalmologist, the ophthalmologist should be thoroughly competent in diagnostic orthoptics and at least conversant with the principles of therapy in orthoptics. An ophthalmologist should not lean too heavily on an orthoptic technician for basic information or advice. On the other hand, no ophthalmologist has the time or training to be expert in all the detail of orthoptic treatment. He may well seek the orthoptist's opinion in specific problems of diagnosis, and he will logically wish to know whether she believes a projected course of therapy will be effective in her hands. For me, the enthusiastic cooperation of an orthoptist working in my office has been a stimulating and valuable experience.

There is a rather widespread impression that the major amblyoscope is an instrument that only the orthoptist may operate. While it is true that the orthoptic technician must be an expert on the troposcope or synoptophore, I feel that more emphasis should be placed on the use of this instrument by the ophthalmologist. In too few residencies are the ophthalmologists expected to become proficient in its use. After having worked several years without an orthoptist, I believe that the major amblyoscope is an instrument of basic importance to the ophthalmologist in ocular motility. Every serious student of ocular motility should purchase his own instrument and become expert in its use, even if he employs it only for diagnosis.

As Miss MacLean will point out, there are methods of determining retinal correspondence other than those using the major amblyoscope but to me this vital differentiation between anomalous retinal correspondence and normal retinal correspondence is not always easy to establish. It is most reassuring to be able to check the objective and subjective measurements on the major amblyoscope. Perhaps the most common

mistake made by pseudo-orthoptists is this failure to recognize anomalous retinal correspondence. When a patient with anomalous retinal correspondence is allowed to set an instrument at his subjective angle, exercises are given that serve only to fortify this anomalous relationship. Unless an ophthalmologist will take the trouble to be certain that fusion training is always given at the objective angle, he had better restrict his orthoptic training to patients with heterophoria.

SELECTION OF CASES FOR ORTHOPTICS

The selection of cases is particularly important for the ophthalmalogist who must do his own orthoptics. He should concentrate on those patients who will derive the most benefit; he should not waste time on individuals who either do not need exercises or cannot be expected to respond to them. There are some general factors affecting case selection which are worthy of attention.

One of the essentials of successful orthoptic training lies in the cooperation of the patient. Nothing is to be gained in trying to help individuals who either cannot or will not try to cooperate. This failure may be due to age or immaturity or nervous temperament. One rapidly learns to size up a patient's potentialities as a candidate for exercises.

There is no hard and fast rule as to the age at which a child may first benefit from orthoptic training. Some youngsters are able to maintain attention and follow instructions even before their fourth birthday. If exercises are to be given, they should be undertaken as early as possible while the child is still in the "plastic state" and before improper binocular reflexes have become firmly established. Most children become fixed in their binocular pattern at around 7 years, so the optimum period for orthoptic training in children lies in this short interval between 4 and 7 years. The child must be old enough to cooperate and yet young enough to be pliable.

The direction of the deviation has bearing on the likelihood of improvement with exercises. Horizontal deviations may be amenable to orthoptics but vertical and torsional anomalies are less often helped. Exophoria and exotropia usually respond more readily than nonaccommodative esophoria or esotropia. The treatment of accommodative squint, however, may be most rewarding.

Comitant deviations are more likely to benefit from exercises than noncomitant anomalies. True paralytic lesions of the extraocular muscles should not be treated with orthoptics.

Gross inequalities of vision in the two eyes are a serious obstacle to fusion, whether this is due to ambylopia which has not responded to treatment, or to an organic defect. Such patients are poor prospects for improvement with orthoptic training and therefore should not be treated by one who has limited time or facilities.

The proper and adequate treatment of amblyopia is indeed one of the major responsibilities of any ophthalmologist, whatever may be his concern with orthoptics. A casual approach to this problem of impaired vision in the preschool child is to be deplored. When the child has a central fixation, a vigorous attempt should be made to correct the amblyopia with complete and constant occlusion. Perhaps with the work that is now being carried forward in pleoptics, we may soon be in a position to offer more to the child with eccentric fixation. I am delighted that

Miss Fowler is going to emphasize the management of amblyopia.

The ophthalmologist, like the orthoptist, may want to employ certain home exercises to supplement what he is able to accomplish in his office. This is certainly desirable, but such exercises should be carefully chosen for specific cases. Some well intentioned practitioners feel they "ought to be doing something about orthoptics" and recommend such instruments as the hand stereoscope or the orthofusor without adequate instruction in their use. Such indiscriminate use of these binocular exercises may satisfy the ophthalmologist's urge to do something but it is likely to be ineffectual and discouraging to the patient. Most ophthalmologists working by themselves may do well to restrict the use of these instruments to patients with heterophoria so far as home exercises are concerned.

I shall now consider briefly some of the indications for orthoptics in the following categories: (1) the heterophorias, (2) the phoria-tropias, and (3) comitant manifest strabismus.

The heterophorias are the proper starting point for any student of orthoptics. Here the fusion mechanism is intact and the complicating factors of amblyopia, suppression and anomalous retinal correspondence are absent. Once fusion has been demonstrated, as Miss MacLean will point out, and the type of the deviation established, a logical treatment may be outlined. The convergence insufficiencies respond particularly well to orthoptic training, and home exercises may be most helpful.

The phoria-tropias are also good subjects for orthoptic training. However, since they are manifest squints part of the time and readily suppress as the eye deviates, they require more careful supervision. Divergence excess with fusion for near and exotropia with suppression for distance are good candidates for training in conscious diplopia combined with recession exercises, etc. This also includes accommodative convergent strabismus, which may readily fuse for distance only to break into a manifest esotropia with suppression at close range. Miss Fowler will describe the management of these cases.

When treating patients with constant tropias the ophthalmologist doing his own orthoptics is likely to need the most guidance. This is particularly true in treatment of monocular convergent squints, which are prone to develop the triad of suppression, amblyopia and anomalous retinal correspondence. For less deeply seated anomalous retinal correspondence encountered in patients with exotropia, orthoptic treatment before surgical treatment may be less important. Normal retinal correspondence indicates postoperative fusion training. I do not believe it essential to treat anomalous retinal correspondence in patients with alternating esotropia and good vision in each eye.

Early surgical treatment has been stressed as the best means of avoiding the establishment of anomalous retinal correspondence. A suitable patient should be surgically treated before his second birthday. Before surgical treatment of even very young patients with monocular strabismus, the ophthalmologist should try to create alternation by occlusion. Again, when retinal correspondence is normal, postoperative fusion training is ideal.

In spite of the present emphasis on early referrals of patients with strabismus to the ophthalmologist, I continue to see for the first time patients with constant strabismus who are already in their fifth to seventh years.

In this age group the complete and constant occlusion of the deviating eye is of vital importance and this step should not be omitted by any ophthalmologist. Occlusion serves as a passive treatment for any anomalous retinal correspondence present as well as for the amblyopia. With these children, who are still in the plastic age, a maximal orthoptic effort is indicated.

Older patients show a high incidence of anomalous retinal correspondence and are often best let alone. Surgical intervention may be recommended for cosmetic reasons but postoperative diplopia is always a possibility. These mature squints are poor candidates for orthoptics even with the most competent assistance.

In conclusion, an ophthalmologist can do much in the way of orthoptic training without the aid of an orthoptic technician. It is most important, however, that the diagnosis be firmly established and that cases to receive orthoptic treatment be carefully selected.

Symposium: Office Orthoptics by the Ophthalmologist

DIAGNOSTIC ORTHOPTICS

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IN this paper I will describe and evaluate certain diagnostic orthoptic techniques which can be done by the ophthalmologist who does not have the services of an orthoptic technician, or the use of such equipment as a major amblyoscope.

The primary purpose of an orthoptic analysis is to furnish the ophthalmologist with additional information regarding the binocular motor and sensorial functions so that an accurate diagnosis can be made, suitable treatment prescribed, and a prognosis given. The analysis includes tests to determine the visual acuity, the fixation pattern, the degree of deviation, the type of retinal correspondence, and the suppression pattern. In addition, the analysis includes the ability to elicit diplopia, the accommodation-convergence relationship, the range of fusion, the amplitude of relative fusional divergence, the presence or absence of stereopsis, and the patient's ability to respond to treatment.[5b]

Accurate information about the patient's motor and sensory status cannot be learned without a knowledge of his fixation pattern. It is important to know whether the patient can fixate monocularly with each eye, and whether the fixation is steady or unsteady, central or eccentric.

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Knowledge of the fixation pattern may be ascertained by the visual acuity test. If fixation is unsteady or eccentric in one eye, the visual acuity is expected to be 20/200 or less and strabismus probably occurred at an early age. If fixation is stable and central, the visual acuity is expected to be better than 20/200 with the strabismus of later onset and the prognosis more favorable. In any case, the treatment procedure will be influenced by the fixation pattern.

One must be aware of the manner in which a patient reacts to a visual acuity chart. To secure accuracy in the test, the patient not only must look at the test object, but he must also have a desire to see it and must state what he sees. Testing the visual acuity of children is an art which taxes the ingenuity of any examiner, and failure to put the child at ease and to secure his cooperation, or failure to recognize his behavior pattern and limitations of attention span, results in false information. A young child's world is at his finger tips. He is more interested in objects at near range than at 20 feet. His gross attention span at 6 years is about 20 minutes; his attention span for detail is perhaps two minutes. Under 6 years the length of time is less and is more variable.

It may be more important to know how a child sees than to know how he measures up on a visual acuity chart, for some children believed to

be amblyopic have been found to have normal vision when interested in seeing. Sometimes a subtle means of testing the vision is necessary to secure accurate information.[5a, c]

The illiterate "E" chart at 20 feet seems to be the test of choice for children up to 6 years, while letter and number charts are the choice for older patients. The Lebensohn and Jaeger charts and the accommodometer are used for near vision testing and for determining the accommodation skill.[4f]

The prism and alternate cover test is perhaps the most accurate and useful test available for measuring the deviation. It is objective and creates the least disturbance. This test can be done at far and near as well as in the cardinal directions, including the up-front and down-front positions which determine the presence or absence of the A-V syndromes; it is applicable in heterophoria and strabismus. By means of the alternate cover technique, which dissociates the two eyes, the full amount of the deviation can be measured by using prisms of various strengths until all movement in the two eyes is stopped. The measurements in the cardinal directions of gaze determine in what field of action the maximum deviation occurs, aid in distinguishing between primary and secondary deviations and reveal overaction and underaction of the muscles.[4a]

The phi phenomenon adds a subjective refinement to the prism and cover test. When alternately occluding the eyes of a patient with a deviation, an apparent jump of the fixation target will be noted if normal retinal correspondence is present. There will be no jump if abnormal retinal correspondence is present, or if the patient is orthophoric with good fusional amplitudes.[9b]

The Maddox wing for near affords a rapid means of testing and measuring heterophoria subjectively. Horizontal and vertical deviations are measured in prism diopters; cyclophoria is measured in degrees. Unstable binocularity is indicated if the arrows deviate back and forth over a range of numbers. The instrument cannot be used to measure a deviation greater than 15 prism diopters of esophoria or 22 prism diopters of exophoria. It is not too successful in testing an alternating or a monocular deviation with deep suppression; however, a knowledge of the suppression pattern can be learned. Abnormal retinal correspondence for near can be determined in some cases, by comparing the prism and cover measurement with that of the Maddox wing. If abnormal retinal correspondence is present, the measurement on the Maddox wing will be less.[4e, 6c]

The Worth-Black amblyoscope may be used to measure an inward deviation of 45 degrees, an outward deviation of 30 degrees, and a vertical deviation up to 24 degrees. It may also be employed to evaluate the fusion status. Minus lenses can be inserted in the auxiliary cells for testing at the near positions. The findings are purely subjective and should be compared with objective tests.

Diplopia is one of the sensorial relationships which a patient experiences when fusion is first lost. It is present before suppression is established. The presence or absence of diplopia is a diagnostic and prognostic clue for the examiner. The ease or difficulty with which it can be elicited furnishes some data as to the depth of suppression and the efforts required to establish fusion. Diplopia tests help to determine the retinal correspondence of the two eyes, as well as the presence or ab-

sence of suppression and, since they approximate a more normal situation than other tests, they are invaluable in diagnosis. Various tests bring out different factors. Diplopia tests commonly used are Worth four-dot, red glass, Maddox rod, loose prism and Lancaster red-green.

The Worth four-dot test can be done at distance and at near to determine whether the patient has diplopia, suppression or peripheral fusion. The size of the dots can be reduced to the equivalent of 20/30 vision for near testing to determine foveal fusion or suppression. The red and green goggles which are worn during the test are reversible, so that the red glass can be worn over the dominant or the nondominant eye. This adjustment is significant since some patients will suppress with the green glass over the nondominant eye but fuse with the red glass, indicating potential intermittent fusion. If diplopia is present, it is possible in some cases to place prisms over one eye to determine the patient's ability to fuse. If abnormal retinal correspondence is present and the suppression is not too deep, the horizontal lights will appear to the right or left of the vertical lights. If abnormal retinal correspondence is harmonious the lights may be fused.[4c,6a]

The red glass or red kodaloid diplopia test is invaluable in determining the depth of suppression. If a single red kodaloid over one eye can easily stimulate diplopia, it suggests that the patient has some binocular vision and can hold fixation with both eyes. His prognosis for fusion is favorable. If three, four or five layers of red kodaloid are required to stimulate diplopia, the suppression is deep, the deviation is usually of long duration and the prognosis is less favorable; the treatment period will be longer and greater effort will be required to establish binocular single vision.[1]

The red glass diplopia test may be used subjectively to test the near point of convergence, and will often explain the reason for a patient's complaints. Some patients will show a normal near point when tested objectively with a light or small test object, but if a red glass is placed over one eye and the test is repeated, the red glass near point may be remote. Since a red glass tends to dissociate the two eyes, a test done in this manner indicates the patient's near point limitations under duress, and shows that his voluntary convergence is not active enough to help him use his eyes in prolonged close work without great effort.

The red glass diplopia test combined with loose prisms may be used to determine abnormal retinal correspondence. If the patient sees two lights with the red glass over one eye, and if the lights are crossed when an esotropia is present and uncrossed when an exotropia is present, abnormal retinal correspondence is likely. If there is no crossing at first, prisms of various strengths may be used to determine the crossing point. If it occurs with the strength of the prism which equals the deviation found with the prism and cover test, normal retinal correspondence is present. If eyes cross with a prism which is five prism diopters less than the deviation, abnormal retinal correspondence is present, and the subjective angle of squint is indicated by the crossing point.

In some cases, suppression may be too deep for the patient to recognize the two lights with the red glass. In that case a vertical prism of four or five prism diopters may help to take the image before the deviating eye

out of the suppression area. This gives the patient an opportunity to see both lights at the same time. However, if the suppression area is very large, the lights will not always be seen to coincide exactly in any position, whether the patient has normal or abnormal retinal correspondence. The patient may change his accommodation, thereby changing the amount of deviation, which may be interpreted as abnormal retinal correspondence. The red glass findings should always be checked with other tests.

Diplopia can also be determined by means of a fixation light, and the deviation can be measured with loose prisms, prism bar or rotary prism. This technique is particularly helpful in determining the location of a suppression area in patients with intermittent fusion. We are all familiar with the patient who has been brought to the clinic because the mother thought one eye turned in or out occasionally, yet during a routine examination no strabismus is revealed.

In the absence of diplopia, if fusion is intermittent there should be a suppression area. To test for this area in intermittent esotropia, base-in prisms are used since the suppression area would be on the nasal side of the retina. Relative divergence is determined by the first base-in prism which causes a diplopia which the patient cannot overcome.

If testing is continued with stronger base-in prisms, a point is eventually reached where diplopia is not recognized, and if the test is continued further the patient will report diplopia again. For example, he may report diplopia with a 10 base-in prism but not recognize diplopia again until a 20 base-in prism is used. It is possible to assume that a suppression area exists between 10 and 20 prism diopters base in. If intermittent exotropia is present, the suppression area will be in the temporal side of the retina and the test is done with base-out prisms.

Intermittent strabismus is also discovered by utilizing physiologic diplopia. The test should be done at far for an outward deviation, since suppression is more likely to show up when the patient is not accommodating; it should be done at near for an inward deviation because suppression may follow accommodation.

The stereoscope is not designed to measure the amount of deviation; it is primarily a training instrument. However, it can be used in diagnostic tests to determine the presence or absence of macular fusion, and the amount of accommodation the patient can exert and still maintain fusion. If the inward deviation is greater than 30 prism diopters, or the outward deviation is greater than 44 prism diopters, supplementary prisms must be used. The patient must have normal retinal correspondence, and the vertical deviation must not exceed one prism diopter.

The stereoscope can also be used diagnostically to determine cyclophoria or cyclotropia. Place a card with two parallel horizontal lines about an inch apart before one eye, and one horizontal line midway between the other two before the fellow eye. The lines are drawn so that the patient always sees three lines, with the middle line halfway between the other two. If a torsional deviation is present, the middle line will be tilted and the direction of the tilt will indicate the type of cyclophoria existing. If the middle line is inclined toward the opposite side, excyclophoria is present; if it is inclined toward the same side, there is an incyclophoria.

The Maddox rod test is particularly valuable in detecting hyperphoria both for distance and near and is preferable to the cover test, because primary and secondary deviations are easily recognized. This test is for patients with heterophorias although it may be applied to patients with strabismus. If suppression is deep or the patient alternates, he may have difficulty seeing the line and the light at the same time. The patient with heterophoria has a tendency to fuse the line and the light; this may reduce the amount of the measured deviation, particularly if the test is done in a lighted room.[4b,d, 6b, 9a]

The Lancaster red-green test is valuable in diagnosing a paretic elevator or depressor muscle, in measuring horizontal deviations and in detecting abnormal retinal correspondence. Since each eye is given the opportunity to be the fixing eye, primary and secondary deviations may be differentiated. The test is intriguing to children; the patient finds it more difficult to suppress; and the findings are more easily interpreted. When testing for vertical deviations the separation of the images should not only be recorded in the cardinal positions, but also with the head tilted to each shoulder and with the eyes directed toward the center of the screen.[10] The Lancaster red-green test is considered the most accurate test for verifying the blind spot syndrome. It also may be used to measure a suppression area.

Since accommodation and convergence are associated activities in the function of the two eyes, a knowledge of their relationship and a measurement of their exertion is necessary in diagnosis, particularly of accommodative esotropia. In this respect it is important to know the basic esophoria, the punctum proximum, the accommodation-convergence ratio and the amplitude of relative fusional divergence.

There are two important factors in accommodative esotropia. The first is hypermetropia and the second is an abnormal accommodation-convergence relationship. A secondary factor is the basic esophoria, which is the amount of malalignment which cannot be corrected by nonsurgical means. A measurement of the basic esophoria is necessary for diagnosis, since in some patients it must be corrected before the accommodative factor can be successfully controlled. Basic esophoria is measured by the prism and cover test while the patient identifies a 20/30 symbol at 20 feet with the refractive error neutralized.[8a,11]

The punctum proximum or near point of accommodation determines the power of absolute accommodation and is measured monocularly with the Prince rule or the accommodometer. One eye is occluded while the fixation symbol, a 20/30 type letter, is placed so closely to the fixing eye that it is blurred beyond recognition and is slowly moved away from the eye until the patient sees and identifies it clearly. The reading on the Prince rule or accommodometer will decide whether the near point of accommodation is average or remote for the patient's age. At age 7 you would expect a near point of 70 mm. If the child has less than 100 mm., he has an average near point; if over 100 mm., it is remote, and in order to see clearly at near he must exert additional accommodation which stimulates excessive convergence.[3, 12]

The accommodation-convergence relationship is determined by comparing the prism and cover measurements at 20 feet and at 13 inches,

with the patient wearing full correction, and the accommodation controlled by requiring the patient to identify small symbols, such as 20/30 letters. A normal accommodation-convergence relationship exists if the measurements for distance and near are equal. If the measurement is greater at 13 inches than at 20 feet, an abnormal relationship is present which is associated with accommodative esotropia. If the patient has esophoria at far and esotropia at near, a significant abnormal accommodation-convergence reflex will be recognized.[8b]

Normally, the relationship between accommodation and convergence is subject to adjustment, a fact which is important in the diagnosis and treatment of strabismus. This adjustment, better known as dissociation, is made possible by altering one function while the other remains constant. The controlling element in dissociation is the amplitude of relative fusional divergence. Regardless of the amount of abnormal relationship between accommodation and convergence, and the amount of basic esophoria and hypermetropia present, the amplitude of relative fusional divergence compensates for these three if it is greater than the excessive convergence brought on when accommodating. If the amplitude of relative fusional divergence is insufficient for the convergence, esotropia ensues.[2, 7]

The amplitude of relative fusional divergence can be measured indirectly by using lenses and the prism and cover test. This is done by neutralizing the refractive error while requiring the patient to identify 20/30 symbols at 13 inches. This calls for three meter angles of convergence while the accommodation is controlled. A cover-uncover test is then done to determine the presence of clear binocular single vision, and if this is found, minus lenses of equal value are superimposed before each eye, followed with additional cover-uncover tests. As the minus lenses are increased so also is the accommodation; in order to overcome the excessive convergence which may follow the increased accommodation, relative fusional divergence must be applied. When the relative fusional divergence cannot overcome the convergence, accommodative esotropia is manifested. If a prism and cover test is done with the last minus lenses which permit clear binocular single vision, this prism measurement will be approximately the relative fusional divergence, and if it exceeds the convergence, it is adequate for the accommodation.[7,11]

If accommodative esotropia is present only at 13 inches, the relative fusional divergence is determined by superimposing plus lenses until fusion is possible while identifying the symbols. Fixating a light instead of a 20/30 symbol at 13 inches does not determine the relative fusional divergence. Accommodation is not controlled with light fixation as it is when identifying a 20/30 symbol.[8c]

Two common tests for stereopsis are the house fly and the Wirt test. The former is interesting to children and determines the presence of any stereopsis. The latter will reveal the grade of stereopsis.

CONCLUSION

Knowledge of the visual acuity is of vital importance for it exposes the fixation pattern. The prism and cover test is a basic method of determining the objective angle. The red glass test together with prisms and the Maddox rod and the Lancaster red-green tests are simple and satisfactory means of determining the sub-

jective angle. The Worth four-dot, Worth-Black amblyoscope and the stereoscope may be used to evaluate the fusion status. Tests for basic esophoria, the punctum proximum and amplitude of relative fusional divergence are clues in diagnosing accommodative esotropia.

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Symposium: Office Orthoptics by the Ophthalmologist

OFFICE THERAPEUTICS: LIMITATIONS AND POSSIBILITIES

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RE-EDUCATION of the visual sensorium is a very complicated process involving the breaking down of old habits, the substitution of new habits, conditioning and reconditioning. It is not a sudden result, as in surgical treatment, but a process of education before and after surgical treatment, so that when parallelism is restored or nearly restored, functional binocular vision may be obtained.

In spite of a careful and correct first diagnosis, difficulties may still occur. As treatment progresses, sensory changes take place, and a series of re-evaluations as to fixation, retinal correspondence, suppression and fusion possibilities must continuously be made. For example, before suppression is fully eliminated, one must have strong evidence of fusion possibility, otherwise there is the risk of creating an intractable diplopia. The ophthalmologist or orthoptist should know when a patient is far enough advanced to go another step or be able to help him over a barrier. The knowledge of when to push, when to rest, when to give up, comes with continuous experience in therapy over a long period of time. In short, it is possible that unless one does a great deal of therapy, one might not be successful in achieving results.

A further difficulty is that orthoptic treatment may require frequent and regular visits over a considerable period of time, time which is seldom available to an ophthalmologist.

The science of orthoptics would never have evolved without the creative efforts of certain great ophthalmologists, working in their own offices, who realized that vision has a sensory aspect that can be educated. One of the first was Louis Emile Javal, director of the Laboratory of Ophthalmology at the Sorbonne, who was, among other things, the inventor of the Javal grid, and therefore the founder of the technique we call bar reading. Rémy devised the Rémy separator and diploscope, which we use in modified forms today. Claude Worth contributed the original Worth amblyoscope on which the major amblyoscope is based, and the four-dot test.

The foundation of orthoptics as a therapeutic science must be attributed largely to Ernest Maddox. He gave us the Maddox rod and wing, both still the best diagnostic tests for heterophoria, and the cheiroscope. It was his daughter, Mary Maddox, who opened the first orthoptic clinic in a London hospital, and who devised slides and therapeutic techniques on which our treatment is largely based.

University of California at Los Angeles Medical Center, Los Angeles.

Presented at the Annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Oct. 12, 1958, Chicago.

We all know the great value to orthoptics of such men as Walter B. Lancaster, and the many current names in the field of ocular motility, but the few names I have mentioned come to mind because of the practical apparatus and ideas they have contributed towards therapy.

SENSORY ANOMALIES

Amblyopia Ex Anopsia

When amblyopia ex anopsia is present, occlusion of the good eye should be constant and total. Part-time occlusion has generally proved valueless. Visual acuity of the amblyopic eye quickly drops each time the dominant eye is allowed to fixate again. Anomalous retinal correspondence may develop or be reinforced during the non-occluded periods. Both mother and child plead for part-time occlusion, but experience shows that the child readily adapts to total occlusion after the preliminary period, whereas part-time occlusion is a daily psychological irritant.

The Elastoplast patches which adhere to the skin can be pleated at the temporal side, allowing air to circulate. Often the patch is left off because of skin irritation. This can be combated in two ways: by varying the size of the patch, or by applying a large Elastoplast patch on the glasses, extending it well over nosepiece, temple, forehead and cheek. At the nose, where peeking almost always takes place, it can be reinforced by a small strip of adhesive.

However, partial occlusion, such as with music tape or lacquer on the lens, may be indicated when the visual axes are parallel, as in accommodative strabismus with amblyopia, or amblyopia with straight eyes.

When an infant has monocular strabismus, amblyopia ex anopsia can be assumed although it is impossible to measure visual acuity. Occlude the fixating eye, but check fixation every few days, since an infant's visual acuity will drop quickly in the covered eye, and fixation may be changed over to the other eye in a matter of days. In children over 3 years, when it is possible to measure visual acuity, vision should be tested at least once a month. If fixation of the non-occluded eye is central and steady, occlusion can be continued; if it is eccentric at the end of a month, further occlusion is useless, and surgical intervention for cosmetic improvement should be considered.

Occlusion should be discontinued under certain conditions.

1. Fixation in the amblyopic eye is not central after one month.
2. Visual acuity does not improve after six weeks. The near visual acuity may be improved, even when improvement is not evidenced at twenty feet. Visual acuity should be checked and improvement noted at both far and near.
3. A small deviation increases or an angle appears, unless surgical intervention is planned.
4. Psychological upset is too great.

Occlusion is therefore continued as long as vision is improving and until the child can alternate fixation.

Alternation of fixation can be taught. When this is difficult, red and green glasses can be used. The child, wearing the glasses, fixates a light, and is taught first to hold either color for a short time, then to change fixation, thus changing the color. He is told to notice how his eyes feel as he changes fixation, and finally to make the same change of fixation without the red and green glasses.

If fixation of one eye persists after vision is equal, a red glass can be used in front of the dominant eye, while pictures printed in red are traced. This forces fixation of the nondominant eye, without complete occlusion of the dominant eye, a task more exacting than similar near work with the good eye occluded.

Anomalous Retinal Correspondence

If strabismus is monocular, the dominant eye should be occluded until surgical treatment is finished. If, however, the strabismus is alternating, occlusion is of doubtful value. It is a passive therapy, preventing reinforcement of the anomalous association, but doing nothing to educate the normal. Against its questionable value we must weigh the psychological disadvantages of occlusion.

Occlusion for anomalous retinal correspondence without training in fusion is a somewhat dubious course. It might be better to operate early for parallelism, and hope that with the new position of the visual axes, spontaneous fusion will ensue.

Retinal correspondence is assumed to be normal for the rest of this discussion.

Suppression

Failure to eliminate suppression is one of the main causes of unsuccessful treatment of strabismus. Yet, having determined that retinal correspondence is normal, elimination of suppression in children older than 7 years is not warranted without some evidence of fusion, as permanent diplopia may result. In children younger than 7, antisuppression exercises can be given routinely. If fusion does not develop, suppression will almost always recur in children younger than 7 years.

Suppression may be treated by a series of steps.

1. Partial occlusion. Occlusion is limited to the suppressing field by an opaque covering on the lens. If one eye habitually deviates and suppresses at near only, and the visual acuity is equal, the lower half of the lens in front of the dominant eye can be occluded, forcing fixation of the deviating eye at that distance. This is often the treatment for accommodative strabismus when the child has single binocular vision for distance, but habitually suppresses one eye on accommodation. When the hypertropic eye is the suppressing eye, occlusion of the lower half of the hypotropic eye is indicated, forcing use of the hypertropic eye in the lower field.

2. Recognition of diplopia. Preoperatively, the patient should be aware of homonymous diplopia when he has esotropia, of crossed diplopia when he has exotropia, and of vertical diplopia when hypertropia is present. He may, while alternating with the red glass before one eye, become aware of two images spontaneously. If he does not, a vertical prism of about 10 diopters held before one eye will often elicit the diplopia by taking the image out of the customary suppression area. Smaller prisms should be substituted, while diplopia is maintained, until none is needed. A septum held between the two eyes will often elicit the diplopia. If the angle of deviation is large, a base-in or base-out prism partially correcting the angle can be used. Next, the patient must obtain diplopia without the red filter, with either eye fixing, and at all distances from far to near. Finally, he must transfer this recognition of a double light in the office, to everyday objects at home.

At this stage the two images are nearer together at some distances. For example, in esotropia, the images are close together at the crossing of the visual axes at the near point of convergence. At such a point, a fusional movement may take place voluntarily or spontaneously.

3. The third main group of antisuppression exercises involves recognition of physiologic diplopia when single binocular vision is intermittently present, as in accommodative strabismus, intermittent exotropia or heterophoria. The patient who is bifoveal for far, fixates a distant light, and learns to recognize that a pencil held between his eyes and the distant light is seen as crossed diplopia. If he is bifoveal at near, he fixates a near object and learns to recognize that a distant light is seen as homonymous diplopia. Physiologic diplopia is a vergence exercise, horizontal or vertical, in its use with stereograms. The technique of bar reading is based on it, using print as the fixation object. Bar reading is an invaluable technique for anyone who has poor binocular hold at *near*, hence, for accommodative esotropia, esophoria or exophoria at near, and also for convergence insufficiency or excess, and ciliary or convergence spasm.

4. Good supplementary antisuppression exercise is provided by red tracings or printed material for use with a red filter. The red filter is worn in front of the dominant eye while the child traces over red drawings or print. The suppressing eye sees both the red drawing and the pencil; the dominant eye sees only the pencil. Excellent stimulus for the suppressing eye is thus provided. The cheiroscope is also a useful supplement. It is arranged so that one eye sees a picture reflected on paper at the base of the instrument. The other eye sees a pencil held in the patient's hand. He is asked to trace the picture. Thus, the patient's own hand and pencil provide a moving stimulus for the suppressing eye. At first he will have great difficulty in seeing both picture and pencil at the same time. If alternation takes place, the tracing will not compare in size with the original. The traceograph is used in much the same way as the cheiroscope, with an additional adjustment for the angle of deviation of the two eyes.

POSTOPERATIVE ORTHOPTICS

In most cases in which surgical treatment is given, orthoptic therapy will be carried on postoperatively. Postoperatively, it is essential to know the whole sensorial picture on the major amblyoscope, and especially to know whether fusion, central or peripheral, is present. Then appropriate exercises can be given to stabilize the postoperative position.

In office therapy, occlusion is often desirable immediately postoperatively, to maintain the position nearest parallelism, or to prevent suppression and the consequent development of a new angle. The fixating eye is occluded if there is a remaining angle, provided the secondary deviation is not greater than the primary. I have done this even in postoperative *exotropia*, and found the amount of deviation lessening with the occlusion. It is important to see the child frequently during the first postoperative days.

Some authorities use prisms to correct a small remaining angle if fusion is present and single binocular vision can be obtained. However, I feel that prisms should be reduced and removed as soon as possible for two

reasons: (1) you are ensuring that the deviation will not lessen, because the fusion you obtain with the prisms will keep the eyes in this position of remaining deviation, and (2) you have removed the stimulus which might allow the patient to overcome that deviation.

A residual postoperative hypertropia often can be controlled by a total or half occlusion on the glass in front of the *hypotropic* eye, thus ensuring that the hypertropic eye is used for visual tasks in the lower field. A prompt reduction of hypertropia often results.

If the child has hypermetropia and a slight postoperative exophoria or exotropia, the plus lens can be reduced to a level just sufficient to give single binocular vision. If slight esophoria or esotropia remains at near, close work should be temporarily discouraged. Atropine used postoperatively for this purpose does not always work, as the child, in attempting to accommodate, will often overconverge rather than relax convergence.

When the patient has single binocular vision at some, but not all, distances, we try to increase the binocular field. One method is with red and green glasses. The distance is found at which a light is seen binocularly, half red and half green; then the patient gradually increases or decreases the distance step by step until fusion breaks, the light becoming double, all red or all green. Sometimes the red and green glasses are unnecessary; the child is aware of diplopia or of the movement of his eye at the break point of fusion. At the break point, an effort is made to rejoin the images, and if successful, another few steps are taken until the whole range from far to near remains in single binocular vision.

Alternately, physiologic diplopia can be obtained at the distance at which the child is bifoveal, and the distance gradually increased or decreased, until the whole range from far to near remains in single binocular vision.

STRABISMUS

Esotropia

When treating esotropia, one should try to equalize the vision with constant occlusion, teach alternation, and use the red filter to arouse recognition of diplopia if retinal correspondence is normal. Remaining postoperative deviation can be controlled with clip-on prisms or lenses, or with occlusion of the dominant eye. If single binocular vision can be demonstrated at any one distance, it can be increased by having the patient approach or recede from the binocular field in an effort to extend it.

Treatment of accommodative esotropia strives to eliminate suppression on accommodation, and dissociate the rigid accommodation-convergence relationship. Treatment may include the following steps:

1. Full cycloplegic correction is given for far.

2. Additional plus lens, in the form of a bifocal, sufficient to make the child bifoveal at near. A plus addition is an aid *only* if it gives the child single binocular vision at near.

3. Antisuppression exercises are given at near, and without glasses for far and near, using fixation objects demanding accommodation.

4. Physiologic diplopia is taught while the visual axes are parallel for distance; the distance is gradually lessened until physiologic diplopia can be obtained at near, and finally at near for print.

5. Voluntary relaxation of accommodation is taught when glasses are removed or reduced, by teaching the child to "blur," and thus "straighten," the visual axes.

6. Voluntary dissociation of accommodation and convergence follows, by teaching the child to "clear" the blurred image while visual axes remain parallel.

7. Bar reading is especially useful if certain precautions are taken. The child must have bifoveal fixation for at least large print, by the addition of clip-on plus lenses or base-out prisms if necessary. His eyes must be watched, and his head held motionless. He will be aware of the two crossed images of the bar between his eyes and the fixated line of print. The central letters will be seen between the two bars, some letters are seen faintly behind the bars, and the outer letters are outside the two bars. Only if he maintains single binocular vision will he be able to read the entire line without pausing to alternate. As reading becomes easier, smaller print is substituted and the strength of clip-ons gradually reduced.

8. The diploscope and the Rémy separator are two small hand instruments useful for the dissociation of accommodation and convergence. The diploscope allows four different accommodation-convergence relationships: the normal accommodation and convergence for print at reading distance, to positions of greater convergence for the given accommodation, and one position of accommodation without convergence. The first and fourth positions are particularly applicable for patients with accommodative strabismus. The Rémy separator, though essentially an instrument for antisuppression on divergence, also provides dissociation practice. By relaxing convergence, the child can see the pictures superimposed; then while maintaining the required parallel position of the visual axes, he can accommodate sufficiently to clear the pictures; thus, dissociation has taken place.

Exotropia

For any type of exotropia, we still try to equalize vision with occlusion. The next important stage is to eliminate suppression at the relaxed position of the visual axes. Recognition of diplopia at the position of greatest exotropia is most important, and often most difficult to obtain. The Rémy separator is used to eliminate suppression at the distance position. The diploscope position of divergence provides antisuppression on divergence. Recognition of diplopia with the red filter is invaluable.

Convergence practice for patients with exotropia is better done postoperatively; then there is less likelihood of postoperative convergence spasm. A small exotropia, especially at near, can be very amenable to orthoptic treatment creating physiologic diplopia at near, and controlled convergence.

HETEROPHORIA

Heterophoria and convergence insufficiency are aspects of ophthalmology still largely ignored. With fusion, these patients hold latent an ocular deviation which, in the case of an adolescent, may increase under conditions of more and more close work. I think the concept that symptom-producing heterophoria is found in the neurotic individual is greatly overemphasized. Among my heterophoric patients at the University of California at Los Angeles who have had contin-

ued comfort after orthoptic training are medical students, football players, professors and their wives. These people were deeply concerned about their eyes but did not appear to be neurotic types at all. In any case, they have remained symptom-free after a good fusional reserve has been established to compensate for the heterophoria.

Esophoria

Esophoria is often accompanied by convergence insufficiency. Therefore convergence must be gradually increased, but with the emphasis on divergence, so that the corresponding convergence-divergence relationship is maintained. The use of base-out prisms in glasses for esophoric patients rarely seems to give more than temporary relief of symtoms. Dissociation of accommodation and convergence can be partially obtained by maintaining clear single binocular vision through increasing the base-in prism. Finally, creating physiologic diplopia for all distances will ensure that suppression does not recur.

I emphasize here that the diplopia elicited in strabismic patients is the awareness of diplopia when one eye is deviated. When single binocular vision is present, as in heterophoria, *physiologic* diplopia is elicited and used to obtain relative vergences and binocular control.

Exophoria

Exophoria, too, requires elimination of suppression. Here the cheiroscope is useful, and physiologic diplopia both far and near is invaluable. Convergence to a pencil, or with base-out prisms, should be followed by a short period of divergence to ensure that the patient will not have more discomfort than before. The full convergence range of the prism bar or phorometer can be mastered for near and later for far fixation. Convergence to a pair of stereograms provides a full convergence range with a stronger fusion hold than that provided by a fixation light, and allows control of the accommodation-convergence relationship.

Hyperphoria

The treatment of a patient with a small amount of hyperphoria is often satisfactory with the use of vertical prisms. These are seldom helpful, however, if the deviation differs in the various directions of gaze.

Vertical vergence in the appropriate direction for the hyperphoria can be very successfully increased by the use of physiologic diplopia with a pair of stereograms. The fused middle image seen stereoscopically provides a strong fusion hold. Then, the pair of stereograms is held, one in each hand, and the fused image is obtained by converging the visual axes. Very slowly lowering the right card while fusion is maintained provides vertical vergence to compensate for a right hyperphoria; very slowly lowering the left card provides vergence to compensate for a left hyperphoria.

If the patient finds it easier to obtain the fused image by letting the visual axes diverge, then the diplopia is crossed and he must lower the card on the side opposite to his hyperphoria (the left card in the case of a right hyperphoria). In order to get a fused image with the stereograms in the first place, the patient with hyperphoria sometimes has to hold one card slightly higher than the other. This discrepancy can be overcome slowly, and the patient is instructed to work toward lowering the higher card to a point an equal amount below, while still maintaining fusion. A patient with up to five diopters of hyperphoria who does not wear glasses and who would prefer not to wear prisms, can

often develop a vertical fusion range which relieves his symptoms completely.

Convergence insufficiency is an excellent subject for office therapy. Convergence insufficiency is not only an anomaly in itself, but it is present with other anomalies: esophoria, exophoria, convergence excess, divergence excess and even accommodative esotropia. Whatever the latent deviation, one has to use the convergence reflex. Often I have heard doctors recommend push-up to a pencil exercise. This is rarely successful without controls. How is the patient to know the point at which one eye deviates without such a control as physiologic diplopia or a red filter? How can one be sure that he will not develop a spasm of overconvergence unless one includes the requisite divergence? How can one be sure that any relief of symptoms obtained will not be merely transient? Here is what can be done.

To ensure that convergence exercises are done correctly, the patient is taught physiologic diplopia by fixating a pencil point held at three-quarter arm's length, and noting the positions of the two images of a distant light. Then, when he draws the pencil toward his eyes, the two images of the light appear to become wider and wider apart, as long as he is converging correctly. At the point at which one eye begins to lag even slightly, the distance between the distant images will cease to widen, even though the patient is not otherwise aware that convergence is not being maintained. Alternatively, a red filter can be held in front of one eye. The patient is then instructed to keep a light fused, that is, seen as neither red nor white but faintly pink as it is brought toward the eyes.

Many children's eyes can converge to a picture held two inches from the eyes, because of the accommodation required to see it, but cannot maintain convergence at the reading distance. Their eyes can be made to converge at two inches, and the fixation object receded from the eyes while bifoveal fixation is maintained. The procedure can be later reversed to ordinary convergence.

If treatment is stopped when the convergence near point is adequate, relief of symptoms is often only temporary. Practice with the base-out prism bar, with stereograms and the stereoscope develop relative convergence, that is, convergence in excess of accommodation, sufficient to provide a more or less lasting compensation.

The presbyopic patient can be helped a great deal by controlled convergence practice. He is suddenly introduced to a plus correction to compensate for his lack of accommodation, and this correction, while increasing his visual acuity at near, inhibits his convergence. It is important, at this stage, to help his relative convergence; as a result he will accept his reading addition much more easily.

PATIENT RELATIONS

Patients who come to me love their doctors and look forward to returning to them for progress checks. However, in visual training, treatments take place once or twice a week, sometimes for many weeks.

Some orthoptists institute discipline from the beginning, impressing the child with a job to be done. Others start out by making a game of the lessons, hoping that the child will think orthoptic training is fun. If you are going to see a child fre-

quently, you cannot make too great a friend of him at the beginning; the work period may degenerate into a play period, and it will be difficult to restore a formal learning situation.

If the task is too easy for the child he will lose interest; if it is too difficult he will be frustrated and even angry. I believe the exercise to be practiced at home should not be one that he is to *try* to do that week, but one that he has *succeeded* in doing for you in the office.

Even an adult is going to be worried or unhappy if he feels he cannot do what you have assigned. An adult must be made to feel that you are intensely interested in his progress. The exercises for heterophoria and especially for convergence insufficiency may seem a somewhat trivial solution for a problem so vital to him as trouble with his eyes. Yet, if you try to rush him, he may become depressed and give up only because he feels incapable of succeeding.

Parents may feel that once visual training has begun the problem will be solved before too long. They will be far more patient if they are given a more or less realistic picture of the steps, including surgical treatment, that may be necessary, and the time that may be required.

In all cases, if progress is not being made, we must search for the barrier. It may be wholly ocular; it may be due to our failure to arouse the child's interest; there may even be psychoneurotic factors.

It is difficult to discuss treatment apart from diagnosis because treatment is never stereotyped. It evolves from knowing the patient, and what may or may not be done for his anomaly according to his own capabilities.

STUDENT TRAINING FOR A CAREER IN ORTHOPTICS

Elsie H. Laughlin

IOWA CITY, IOWA

I have been an observer, promoter, and assistant coordinator of the Basic Course in Orthoptics during its presentation at Iowa City. This course has been held in Sanford, Maine, Boston and St. Louis. During the current summer it will be at Ann Arbor, Michigan.

The questions arising from various interpretations of lecture material, plus the variety of previous experiences in related fields of endeavor, have made these intensive summer courses a challenge to both students and instructors.

Only a few applicants have more than a vague idea of the amount of work and study involved in becoming a certified orthoptist. Consequently, by the end of the second or third week, many are floundering and wondering what line of reasoning could possibly have led them into orthoptics. Those with perfectionist ideas would like to memorize rules, formulas, and definitions which could fit every case. They are upset by the inevitable exceptions and unpredictables (never say "Never" and never say "Always"). Another type of student with a flair for imagination may start off on a tangent involving, for example, a theory of weak muscles, only to be hauled back to reality by certain established physiologic facts.

Then why does the student remain encouraged?

1. The instructor has certain definite convictions about orthoptics as a diagnostic aid to the ophthalmologist and a therapeutic aid to the patient.

2. Any medical auxiliary is valuable in proportion to his or her understanding and use of proper terminology as well as routine techniques. An orthoptist must be a technician plus, and this challenge, together with encouragement from instructors and others who have gone before, provides the stimulus to carry on.

In the didactic material, no detail is insignificant. Although not immediately applied, each bit is presented and made available for future reference and study. As in all learning, when a student begins to understand he also begins to participate. The time allotted for lectures does not allow for much discussion in class but most of the instructors are available for extra help in clarifying difficult points. The repetition afforded by group study during evenings and week ends is also helpful.

The need for a certain amount of planned recreation was recognized in preparing for this concentrated eight weeks of study. Even though our university campus is not in a large city, there are a number of summer activities as well as facilities for picnics, etc. Several dinners at nearby places of interest were planned for the group.

ORIENTATION

The purpose of an orientation week was to provide the students with valuable tools in the way of elementary anatomy, physiology, and terminolo-

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gy, so that they would be more receptive to the rather overwhelming amount of highly specialized material which was to follow; and so that, as concepts began to take form, they would not remain prisoners of their own vocabulary. A written spelling test, given on the first day, revealed that many words held no associations whatsoever with the recruits' previous experience. For example, the word pronounced "strabismus" appeared on a first test paper as "strabusiness." By the end of the first week, a list of 150 difficult words had been mastered by most of the class. All available instruments and gadgets were displayed and briefly demonstrated during the first week so that students would have at least a nodding acquaintance with them.

By the end of the eight-week course, students realize that they have really just begun to study orthoptics. They have learned, also, that a different approach to the same problem does not necessarily mean lack of efficiency or departure from the chief over-all aim: to try to clear the way for a patient to make the best possible use of his two eyes together. They also have been given an awareness of their responsibility as teachers. There seems to be no packaged rule for meeting individual teaching problems. Interested students, in their subsequent practical work, come forth with unique ways of dealing with situations involving personality or behavior. I have often seen a student use patience and friendliness in winning over a child who has resisted many routine attempts at testing. May she never be too pushed to remember that patients are persons!

Having seen a number of these girls at work I am convinced that most of them should be encouraged to just "be themselves" instead of trying to adopt the exact approach used by another technician. If friendly, consistent, sincere, and informed, their own approach will be refreshing and good. However, in my opinion, students should be warned at the beginning, and again if necessary, about mannerisms. There probably is no place where a mannerism can become so obnoxious to patients and co-workers as in the repetitious realm of orthoptics.

The late Dr. Lancaster once wrote, "Much passes for orthoptics which is far removed from the real thing." This state of affairs has been the main reason for continued effort on the part of members of the American Orthoptic Council to provide the best possible facilities for studying orthoptics. They know that the successful orthoptist can do much to advance this branch of ophthalmology. They also know that unethical, poorly applied orthoptics can forever discourage an ophthalmologist from pursuing the functional phase of ocular motility.

A student embarking upon an orthoptic career must learn to feel responsibility as a member of a team consisting of (1) patient, (2) parent, (3) ophthalmologist, and (4) orthoptist. Unless the latter three understand each other and present a united front, they can neither instill the desire nor provide the encouragement which the patient needs in his binocular rehabilitation. The mental integration necessary for accepting binocular vision in the face of faulty habits of long standing, does not come easily. Most of the inspiration and labor must originate with the orthoptist.

This brings to mind a point which is often overlooked—the orthoptist's responsibility to the orthoptist. Orthoptics, taken seriously, as it must be to get results, can be energy con-

suming to the extent that it takes a toll of the orthoptist's health and well-being. The acquisition of outside interests is probably one of the most important factors in preparation for an orthoptic career. Fortunately, many persons entering this field already have an interesting background of experience, which keeps them from becoming one-track individuals and which makes them doubly valuable as members of our profession.

All these and similar matters were discussed during orientation week. It may seem superfluous to stress these very obvious sidelights and details. Certainly those students who have had a part of their practical training or have been otherwise associated with ophthalmology in a teaching capacity, may find it superfluous. But it seems only fair that such a resume be presented, so that wrong impressions or lack of adaptability will not later contribute to the frustration and unhappiness of an ill-chosen profession.

COURSE OF STUDY

Many of you are familiar with the course of study and mimeographed notes prepared for the summer course. The second, third, fourth, and fifth weeks were devoted to lectures in optics, anatomy, physiology, and neuro-ophthalmology by members of our staff and at least six visiting doctors well qualified to teach the subject of ocular motility. Several were members of the American Orthoptic Council.

Each Saturday morning was devoted to review and written examination covering the material presented during the week.

Likewise, the sixth, seventh, and eighth weeks were taken up with lectures by four or five visiting orthoptists. These lectures were supplemented by practical demonstrations and an effort was made to present suitable cases which typified the anomalies treated by orthoptists.

PRACTICAL TRAINING

In addition to the didactic course a student is required to have a total of ten months of practical training under the supervision of a certified orthoptist before being eligible for the Board examinations. As was stated before, some applicants have started practical work before taking the summer basic course. The Orthoptic Council strives to have each student receive practical experience in two or more clinics or offices. There is a difference, for example, between the physical setup of a clinic and that of a private office. Each offers definite advantages to the student. These must be weighed when a permanent location is chosen.

The added responsibility of training students is not happily anticipated by many orthoptists. One is immediately concerned with the problem of space, and of subdividing attention without further interruption or confusion. Even though a student can be of some help almost immediately and will contribute valuable new methods and ideas from recent studies, many pitfalls and time-consuming explanations combine to disrupt work to some extent. This naturally causes concern over the divided allegiance to student and patient. However, those who agree to train students rarely regret having done so. A certain rejuvenation results, a great deal of appreciation is forthcoming, and the veteran orthoptist feels that this is a truly valuable contribution to make for the advancement of our profession.

Obviously the student must also continue a diligent study program

during the practical training period. A full day of appointments leaves little time for more than interested guidance of this study—making available the cases for observation and providing sources of reference material. Pertinent articles in the current literature are discussed and evaluated. To ensure more careful study of "meatier" subjects, some articles are reviewed periodically from a "question box." Another valuable source of help is a battery of previous Orthoptic Council examination questions. Practice in reading questions carefully, as well as writing answers concisely and legibly, is an important phase of preparation for written examinations and for future written reports and correspondence.

Our students are invited to sit in at staff meetings and lectures when motility problems are discussed. They usually assist our residents in some capacity when a research project pertaining to strabismus is in progress or when material is being gathered for a seminar paper. The months pass quickly and it seems that much of the didactics, aside from the basic course, is of the "do it yourself" type.

The students work with strabismic patients all morning. In the afternoon, they have the opportunity of observing one or more of the same patients as they are examined by residents in the clinic and later presented to a staff doctor. This leaves an hour or two for study in either the departmental library or the medical library. The last hour is spent in the orthoptic clinic again, working with patients with heterophoria (usually with convergence insufficiency).

It has been quite satisfactory, from the standpoint of both the student and the office routine, to have students begin by helping with visual acuity testing, and then progress gradually to the more involved procedures. Patients with heterophoria (usually adults) provide an excellent opportunity for gaining confidence and skill in technique and in recording findings. Reports are carefully checked by a senior orthoptist. An orthoptic form for evaluation and progress reporting makes for better accuracy and continuity. In our clinic, a coded cross-filing system has been a definite help in training students to observe and record all possible aspects of a given case. Although "pigeonholing," if taken literally, can be very exasperating, this rather pliable system makes it easier to pick cases for certain studies and to note the progress of the patient over a period of time. Medical records are bulky and available only on the day of examination. The patient's file card, with tabs to denote main classifications and with additional numbers for subdivisions or related conditions, is very helpful for quick summarizations. Copies of our key to this cross-file are available for distribution. No doubt many of you are using something similar. Over a period of time, we have added and subtracted to make the list practicable. For that reason, the order within the groups may seem jumbled, but it serves our purpose well.

The training and encouragement of orthoptic technicians is a responsibility we all must share. Most of us can remember that the understanding support of at least several pioneers helped us to get our start. For this and other obvious reasons, the responsibility of training students takes the form of obligation and duty. The hope of the American Orthoptic Council is that soon students will be able to receive superior training by rotating among several clinics and private offices.

OBSERVATIONS ON TEACHING PROBLEMS

JOAN A. CLAVELL

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Orthoptists may be associated with private clinics, work for individual ophthalmologists, or be appointed to large hospitals and teaching institutions. In these latter establishments orthoptists may teach orthoptics and the general care of strabismic patients to other members of the medical profession.

Teaching diagnosis and treatment of strabismus is the duty of the ophthalmologist and nursing educator, but remember that their time is limited. Both ophthalmologist and nursing educator have wide fields to cover and usually, due to restriction in teaching hours, they cannot devote as much time to each individual problem as they would like. Orthoptics is designed to alleviate this situation and relieve the ophthalmologist of the details involved in dealing with cases of strabismus.

The aim of all medical education is better care for the patients. How this is accomplished, the advantages to be gained, and the problems encountered will be discussed as related to the three following groups: (1) residents in ophthalmology, (2) medical students, and (3) nurses and student nurses.

RESIDENTS IN OPHTHALMOLOGY

The orthoptist can help the resident better understand the treatment of strabismus by (1) eradicating any skepticism and erroneous impressions of orthoptics, (2) correcting faulty techniques of examination, and (3) emphasizing certain procedures.

Eradicating Skepticism and Erroneous Impressions of Orthoptics

Skepticism is undoubtedly less now than it was 10 years ago, but it still persists; the best time to combat this problem is during residency training.

Today the value of orthoptics in diagnosis is acknowledged by most authorities,[1,3,6,12] but skepticism regarding the value of orthoptic *therapy* is much in evidence[6] and seems to have resulted from either of two false concepts: (1) orthoptic therapy is effective in all strabismic problems or (2) orthoptic therapy is useless in all strabismic problems. Added to the difficulty is the attitude of some ophthalmologists that when all else has failed, send the patient to the orthoptic department. Such patients do not usually have therapeutic problems. Often they are postoperative patients; many have deep rooted sensory anomalies, incomitancy or amblyopia and invariably none have had the benefit of a preoperative or previous orthoptic evaluation. It is quite possible with the modern trends in research and the recent advances in techniques that many of these non-therapeutic problems may come within our scope. However, for the time being, we should recognize the extents and limitations[1,5,8,12,13,17] of orthoptic therapy and communicate this information adequately and repeatedly to the ophthalmology resident.

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Each clinical case should be clearly evaluated and discussed; thus we can hope that the resident will be receptive to incorporating any orthoptic aid available in his future practice. In this way the patient will be ensured of all the advantages available to him and possibly spared the needless waste of time and money resulting from false hopes.

Correcting Faulty Techniques of Examination

The diagnostic tests are ably described in the textbooks. However, they must be clearly understood and repeated clinical demonstrations are necessary.

In Harold Whaley Brown's opinion, "The advantages and growing general use of the cover test make it imperative that the beginner in ophthalmic myology becomes thoroughly acquainted with this method of examination."[4] Duke-Elder states, "It is the easiest and one of the most accurate methods of eliciting the presence of a squint whether latent or manifest, lateral or vertical."

Errors in this test arise from the choice of fixation objects. In a busy clinic the fixation object for near is usually a pencil flashlight. Most authorities recommend a point source of light, but many of those used are too large and bright and make sustained fixation by the patient uncomfortable and thus variable. A light source often fails to hold the attention and interest of the patient, and the amount of accommodation involved is debatable. In J. Watson White's opinion, "The size and brilliancy of the test object must be reduced in order better to study the effects of accommodation." Scobee[16] stated, "A point source of light is a definite stimulus to accommodation at one third of a metre."

The position of the object for near fixation is important. The accuracy of the measurement is influenced when the object is held above eye level and measurement of the deviation is estimated by the cover test with prisms, or by comparing the corneal reflexes. This is particularly evident when children are being examined. The proximity of the near object must be considered in testing ocular versions; when it is held too close, it causes uncomfortable convergence in the lateral and oblique fields of gaze, and on extreme versions the nose will act as an occluder.

Fixation during the cover test is not always obtained and checked; often the smaller degrees of heterotropia go unobserved. This is particularly so in Negro patients whose heavily pigmented irides make small monocular eye movements hard to detect.

Difficulties are experienced when incomitant deviations are measured by this test with prisms. The examiners fail to concentrate on neutralizing the movements of the nonfixing eye only, and confuse the results by alternating the cover.

Other errors occur in convergence testing. Sustained convergence testing, invariably to a slowly approaching flashlight, is not repeated; thus a possible fatigue factor remains undetected. Evaluation of the ability of the patient to change focus from a distant to a near object is often omitted. If it is checked, then the facility with which the patient can relax his convergence often is not examined. Failure to test prism vergences and to note the recovery points in these tests, as stressed by Lancaster,[11] is another common error.

Emphasizing Certain Procedures

The ophthalmology resident should be able to perform accurately all the

diagnostic tests and evaluate correctly the evidence obtained. Many doctors will practice without orthoptic assistance because of economic reasons, geographic location or because the demand for orthoptic technicians exceeds the supply.

Adequate investigation and accurate examination are therefore emphasized. Methods of taking an inclusive history and forming a prognosis are important procedures; the value of home exercises should be stressed.

A comprehensive case history is a necessary adjunct in the diagnosis, prognosis and treatment of strabismus.[7,9,13] However, frequently only a few remarks on a chart indicate that strabismus has been investigated; even more frequently a history is obtained but not fully recorded. This facet of strabismic cases was emphasized by Billinghurst[3] who suggested that a more detailed history of the emotional and physical development of these patients may lead to further material for research into the etiology of strabismus.

With regard to forming a prognosis, a prevalent attitude is one of "wait and see." This attitude is refuted by Lyle,[13] who states, "After studying the history of the case of strabismus and after carrying out a thorough examination, it should be possible in most instances to decide what sort of treatment is needed and to give a fairly accurate prognosis with regard to the possibility of restoring binocular single vision." He agrees, however, that in many instances, particularly in the case of young children, several diagnostic sessions may be necessary. Routinely, an over-all view of each case should be taken so that, with the prognosis clearly established, the measures adopted can be carried out without loss of the time and effort of both the ophthalmology resident and the patient.

The value of home exercises should be stressed; the ophthalmology resident should be exposed to manuals such as Functional Home Exercises by Marianne Eyles. The inadequacy of the "finger to nose" exercise so commonly prescribed for convergence deficiency should be stressed. Copies of instructions for patients can be made available to the resident for his future use; the defects which most readily respond to home exercises should be indicated to him, and the advantages to be gained by soliciting both parents' and patient's home co-operation in the treatment emphasized.

Teaching residents by clinical demonstrations and discussion presents a number of problems. The two major difficulties encountered are time and the availability of the ophthalmology resident.

As previously stated, the resident has an extensive field to cover and, to quote Cecil Rhode's phrase, has "so much to do and so little time." It is not uncommon, therefore, to find that the muscle problems receive limited consideration other than from a surgical standpoint. In a busy clinic much of the evaluation falls on the shoulders of the orthoptist, routine in any situation but a teaching one. The resident should see patients with strabismus and heterophoria as often as possible.

The second major difficulty is the availability of the ophthalmology resident. In some hospitals the residents are assigned to certain services for limited periods of time, for example the glaucoma service or the muscle service. In this situation there is a regular change of personnel and many of the patient's problems are not resolved as expeditiously as desired. The orthoptist is the constant factor under

these circumstances and it is her responsibility to prevent this tendency to defer judgment.

The same problem to a lesser degree is evident in situations in which the orthoptist works alongside the residents in the same clinic. In the interests of all concerned, whenever possible, patients especially those who have had surgical treatment should be treated by only one resident. The ideal would be to have each patient seen by all the residents, but this has not been found practical because of the time element.

MEDICAL STUDENTS

Ophthalmology coupled with otorhinolaryngology is a minor course in most medical schools and comprises perhaps a 12-hour lecture series in the fundamental principles of ophthalmology and 12 hours of clinical experience. Since strabismus is only one facet of ophthalmology, this condition often receives scanty attention except in its more obvious clinical aspects.

In orientating medical students during their clinical experience early treatment of these patients and early consultation with an ophthalmologist should be emphasized. In the future, particularly in general practice, these doctors will come into contact with patients with strabismus either directly or through consultations.

The reasons, both functional and psychological, for early treatment should be briefly but clearly explained to them. As expressed by Mason Baird, ". . . it would be a definitely progressive step in treating strabismus if the pediatricians and doctors in general would recognize this fact and refer cases of strabismus at the very first sign of the squint rather than waiting until the child is 2 or 3 years of age." He further observes that treatment should be started as soon as the diagnosis is made, which may be at the age of 4 months.[2]

Lyle draws attention to the psychological trauma involved in this condition and stresses correction before the age of 7 or 8 years at the latest, i.e., before the child reaches the age at which his physical defect begins to worry him and before he reaches the age at which his schoolwork becomes of real importance. Many authorities believe that these defects should be corrected prior to entering school at age 6.

Observation shows that the greatest problem in teaching medical students is again the time element. Practically, therefore, it is better to overemphasize the general considerations rather than to dwell on the complexities of strabismic problems. The development of binocular vision must be discussed briefly, and when time permits, explanations and demonstrations with regard to occlusion and apparent strabismus should be included. It is not always pointed out that an epicanthus cannot only simulate a strabismus, but can also mask such a condition.

NURSES AND STUDENT NURSES

The average nurses' training course includes a course of general ophthalmology lectures during which strabismus is briefly mentioned. If the hospital does not contain a separate eye, ear, nose and throat unit, she will be exposed to the nursing care of eye patients scattered throughout the hospital and may or may not have a strabismic patient under her care. This also applies to the graduate nurse unless she is working in an eye, ear, nose and throat hospital. In any event the nurse's knowledge is usually limited and she frequently has never heard of orthoptics.

To achieve the aim of better care of patients with strabismus or related problems, the nurse should have included in her curriculum an orientation on these conditions and orthoptics. Remember that the lay public will invariably consult a nurse in the early stages of a medical problem. Therefore it is essential that she has accurate information.

It is not necessary to teach the nurse or student nurse all the intricate details of orthoptics, but she should have a general idea of the development of binocular vision, the reasons for occlusion, and the purposes of orthoptics. Emphasis naturally will be laid on early treatment and early consultation with an ophthalmologist.

By interesting nurses in the field of orthoptics and care of patients with strabismus, several advantages are gained. The first is public education. Lynn observed the need for public education so that the patients would be brought for advice as soon as strabismus is noticed.[15]

The nurse is in close contact with the public in many fields: in hospitals and related institutions, on private duty, in offices, in public health, in industry, through nursing education and the well-baby clinics. In the *American Journal of Nursing*, the number of practicing nurses in the continental United States in January 1956, in all fields, is estimated as 430,000; our own register lists 184 orthoptic technicians. The ratio is approximately 2300:1. Public education, therefore, can be fostered if the nurse can act for us by giving sound advice; this sound advice can result in the correction of many erroneous impressions about the treatment of strabismus and the value of orthoptics. The nurse can be responsible for directing the patients to effective treatment and may speed up the process so that treatment can be instituted without delay.

An additional advantage is that our own recruitment can be stimulated with a wider public knowledge of orthoptics. One has only to apply to the Orthoptic Replacement Service to become aware of the vast numbers of ophthalmologists who require the services of an orthoptic technician.

The lack of time for an orientation lecture or clinic is also the major problem in instructing nurses. We need to impress upon the existing nursing educators the need for including this orientation in their program.

By "selling orthoptics," as Moray Girling expresses it,[6] to nurses we can achieve better patient care, a wider public knowledge, and stimulate interest in our profession.

SUMMARY AND CONCLUSIONS

The purposes and problems related to teaching orthoptic diagnosis and treatment to residents in ophthalmology, medical students and nurses have been discussed.

This opportunity affords us many advantages. Primarily the interests of the patient are safeguarded by spreading accurate information throughout these groups.

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THE MODERN TECHNIQUES IN THE TREATMENT OF AMBLYOPIA

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Amblyopia is a state of subnormal vision in an eye for which no organic pathology is demonstrable, and is therefore presumed to be functional. It may be present with or without strabismus. The type which usually concerns us is the type which we encounter in about 50 per cent of cases of convergent strabismus. The severity of amblyopia has no relation to the degree of strabismus. Patients may have a slight amblyopia with a visual acuity between 0.3 to 0.8, moderate amblyopia with visual acuity from 0.1 to 0.3, or severe amblyopia with visual acuity below 0.1. Severe cases of amblyopia may be divided into those with and without central fixation.

Since prophylaxis is the best form of therapy, it should be applied to the management of amblyopia. Every case of strabismus should be suspected of amblyopia, its presence ascertained or its development prevented.

In very young children we begin the examination by determining whether the strabismus is alternating or unilateral. The threat of amblyopia is not serious in alternating strabismus. These patients are more apt to be menaced by abnormal retinal correspondence. It suffices to order any refractive correction necessary and to check the patients frequently for a tendency toward unilateral strabismus. When prescribing the refractive correction it is important to give the patient with suspected amblyopia as clear vision as possible. Myopic patients should have full correction. The objective cylindric correction may be reduced by 0.5 diopter because an objective refraction has a tendency to overcorrect the astigmatism. The hyperopic correction may be reduced by 0.5 to 1 diopter. Children accommodate readily to anisometropia and tolerate a difference of 5 or 6 diopters between the two eyes.

We usually incorporate as strong prisms as are feasible into the glasses. After many years of prescribing prisms we found one advantage indisputable. They solve the problem of getting children to wear their glasses. Many young children object to their glasses just because they are cumbersome; mothers get frustrated in the struggle to get children to wear their glasses. We usually keep the children under cycloplegia for a month following the prescription of the glasses. During this time the children wear them because they are conscious of the visual improvement. Difficulty begins when the cycloplegia wears off because the child is no longer conscious of their benefit. However, if prisms have been incorporated into the glasses this problem rarely arises. By this time the youngster has developed a sensory motor pattern which requires the prisms.

If a child younger than 3 years has a unilateral strabismus, the danger

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of amblyopia is real or amblyopia is already established. We should then make every effort to determine the visual acuity of the two eyes. A fair estimate of visual acuity may be made even in young children.

Bock's method[3] of utilizing the grasp reflex in children younger than 3 years is ingenious. Small colored beads which are used in cake decorating are used as test objects. They are about 1 mm. in diameter and when seen from a distance of two feet they correspond to an acuity of 20/60, which is about normal for a child younger than 3 years. The mother is instructed in practice of the testing. The child is first given a few beads to eat. Then one to three beads are put on the floor a foot apart, one eye is occluded, and the child encouraged to pick up the beads. As the child gets accustomed to the game at home he is apt to be more cooperative when the procedure is repeated in the office. Any difference in the child's behavior in the test of the two eyes may be assumed to be due to an inequality in the visual acuity of the two eyes.

Visual acuity of older children is determined with the Landolt ring or the E chart. Records should indicate whether visual acuity was tested with single letters or a line of letters. Patients with amblyopia show a decided difference between angular and morphoscopic visual acuity. Recent investigations show that the education of an amblyopic eye resembles the recuperation of vision in patients with optic agnosia.

The patient with optic agnosia recognizes first contrasts in lighting, then the white bulk of nurses and physicians around him, then he makes exploring ocular movements, and finally comes recognition of colors and precise forms. Recovery from amblyopia seems to take the same pattern. When the visual acuity of the amblyopic patient is tested by a line of letters it is about half of what it is when tested with one letter at a time. Bangerter[1] pointed out that the difficulty in the recognition of form and separation of a line of letters is characteristic of amblyopia. He devised a special instrument consisting of letters with variable distances between them for training this sensory inadequacy.

The first objective of treatment of amblyopia is the restoration of angular visual acuity, which is the acuity tested with one letter at a time. When the angle of strabismus is greater than 25 degrees or 30 degrees a surgical operation should be performed as a preliminary procedure and the angle of deviation reduced, if not fully corrected. A small degree of residual strabismus may be corrected with prisms incorporated into the glasses.

For the prognosis and indications for occlusion of the fixing eye, which until recently was the orthodox therapeutic procedure in all cases of amblyopia, it is important to determine the pattern of fixation of the amblyopic eye. In very young children this is not easy, particularly if the eccentric area used for fixation is not too distant from the macula.

The diagnosis of the fixation pattern of older children is made with a special device integrated into an ophthalmoscope. With the pupil dilated and the fixing eye occluded, the patient is asked to look into the light of an ophthalmoscope known as the visuscope. With the visuscope a small diamond-shaped figure is projected on the retina. While the child's eye fixates the diamond, its position on the retina shows whether the patient is using the fovea or another retinal area. The use of the visuscope test is helpful, although the diamond covers the foveal reflex and somewhat

obscures the area which one wants to identify as clearly as possible. Nor is the fixation of the diamond always easy; one sometimes sees the foveal reflex move about the diamond even in normal eyes.

There are other devices for the diagnosis of the pattern of fixation.[6] Bangerter uses a green filter with a central opening, so that the yellow light on the fundus identifies the fixation spot. Comberg devised a mirror with an adjustable iris diaphragm; by gradually narrowing the diaphragm the fixing area of the retina becomes constantly more defined. The presence of central fixation in older children can also be determined by Goldman's macula tester. If they have no central fixation they cannot recognize Haidinger's brushes.

If the child sees the diamond projected by the visuscope when you see it on the fovea, it may be assumed that he has central fixation. If the diamond lies outside of the fovea in the macula or outside of the macula he has eccentric fixation. In some cases no constant fixation can be elicited, and the child's fixation appears to be wandering. Eccentric fixation may be subdivided into several types.[6] For the prognosis it is enough to determine whether it is close to the macula or peripheral. In peripheral fixation or vertical displacement of the fixing retinal area the prognosis for recovery from amblyopia is poor.

The treatment of amblyopia with central fixation by means of total occlusion, partial occlusion, atropinization of the fixing eye, and planned retinal stimulation is so well standardized that it needs but brief recapitulation.[7] After refraction and wearing glasses for several weeks the fixing eye is occluded until vision remains constant for six or twelve weeks or until unilateral strabismus is converted into an alternating one. Bangerter, who within the last few years has become the authority on pleoptic therapy, as treatment of amblyopia is now called, does not use total occlusion. In this country Guibor also does not use total occlusion.

Within the first two years, therapy is limited to atropinization of the good eye for three weeks out of every month. This is discontinued if the strabismus becomes alternating, or if fixation fails to improve. Between two and four years of age exercises of the amblyopic eye are instituted for 15 minutes daily, by having the child grasp objects of gradually diminishing sizes while the good eye is occluded. It is important that children enjoy whatever exercises they are doing and not become conditioned against future orthoptic training.

Active training requires a certain degree of intelligence and cooperation, and not very much can be achieved before the fourth or sixth year. A few trials at exercises will determine the child's maturity, intelligence and cooperation. If feasible, training should begin as early as possible, because the learning aptitudes in this field diminish with age. The optimum age seems to be between six and ten years.

A variety of procedures are used to stimulate the fovea of the amblyopic eye. Bangerter designed a number of training appliances based on the principles of providing the most favorable conditions for foveal perception, of intensive foveal stimulation by means of adequate stimuli, of utilizing the relationship between the two eyes, and of utilizing cerebral function and other senses to stimulate visual perception. Many of these appliances are cumbersome, and if feasible his patients are hospitalized for a time. They are treated in his pleoptic school by two one-half hour

treatments on the appliances and two and one-half hours of active exercises daily.

While Bangerter stresses the importance of visual stimulation in the treatment of amblyopia, Francois and James concluded from a controlled study that the end results are the same in cases treated by occlusion of the good eye alone, or by occlusion and visual stimulation, but that the time required to achieve maximum visual acuity is greatly reduced by the combination of visual stimulation and occlusion.[8]

Children whose fixating eyes are constantly occluded should be supervised closely with occlusion discontinued and repeated as indicated until they are ready for orthoptic training, when the two treatments can be integrated. The goal of occlusion is equal vision in both eyes and free alternation which is a requisite for the maintenance of the visual gain. As the child reaches the age when orthoptic training is practical, the development of binocular vision stimulates the visual acuity and helps in maintaining the gains of the amblyopic eye. The greater the fusion amplitude the more secure are the gains made. If binocular vision is obtained, bar reading for one-half hour daily for a year is effective to hold the gain in the amblyopic eye. When no binocular vision is attainable, exercises of the amblyopic eye should be continued regularly and the visual acuity of that eye checked at regular intervals: every three months, six months and finally once a year.

The chief indication for constant occlusion is a visual acuity of 0.2 to 0.3 with central fixation of the amblyopic eye, and to retain recovered central fixation of an eye with an initial eccentric fixation. To retain a recovered central fixation the eye must be used. The patient should be kept under close observation until binocular vision it attained. Until then the use of the previously amblyopic eye can be ensured only by occlusion of the better eye.

The task in treating children with eccentric fixation in the strabismic eye, which is encountered in about one third of the cases of amblyopia, is much more difficult. It is generally admitted now that occlusion of the fixing eye serves to enforce the pathologic sensory-motor visual habits of the eccentrically fixing eye. An eye without central fixation will revert to paramacular fixation under stimulation. For this reason occlusion is contraindicated for eyes without fixation or with eccentric fixation. The more paramacular vision is stimulated, the worse is the prognosis for the cure of the amblyopia. The best visual acuity possible with paramacular fixation is 0.1 to 0.3.

The objectives of therapy of patients with amblyopia with eccentric fixation are restoration of central fixation, development of angular visual acuity and finally development of morphoscopic visual acuity. The prognosis for success depends on hereditary factors, severity of the amblyopia, age and intelligence of the patient. A history of amblyopia in the family is an unfavorable prognostic sign. The prognosis for patients with severe amblyopia with eccentric fixation is fair if treatment is instituted early. Bangerter claims to have obtained good vision in 25 per cent of cases and a definite visual improvement in 50 per cent more. In adults the prognosis is hopeless. The prognosis is good for children with moderate amblyopia and gets poorer as the patient gets older. In mild amblyopia the prognosis is good for children and fairly good for adults.

The closer the fixation area is to the macula, that is, the better the visual acuity which is never above 0.2 or 0.3, the more difficult it is to convert eccentric into central fixation. Patients without fixation have a better prognosis with adequate therapy, because their fixation pattern is still plastic.

Bangerter's method of treatment of patients with amblyopia with eccentric fixation comprises simultaneous intense stimulation of the fovea and depression of the parafoveal perception. These exercises are given for one-half hour twice daily. The fovea is stimulated by intense light while function of the parafoveal area is depressed by dazzling. He carried out the first systematic investigations with this form of therapy. He used at first a modified Nordenson camera for this purpose, and then designed special appliances. He since has devised a number of elaborate instruments for the treatment of the various sensory-motor anomalies. Severe foveal inhibition can be eliminated by stimulation with projection of intermittent light synchronous with an acoustic stimulus as well as by active exercises which utilize the acoustic and tactile senses.

Bangerter's reports interested other investigators in the systematic methods of treatment of amblyopia, and Cüppers[5] developed a method of treatment with negative afterimages which requires less elaborate appliances than those of Bangerter's pleoptic school. The Cüppers' euthyscope, a type of ophthalmoscope, is focused on the fovea and produces a circle of 30 degrees of intense illumination which dazzles the posterior pole of the retina with the exception of a central area 3 or 5 mm. in diameter from which the light is excluded. The illumination, not exceeding 5.5 volts, is maintained for 20 seconds. In order to avoid dazzling the fovea it is first focused through a green filter which also facilitates its recognition. Then the illuminating circle replaces the green filter. As a result of the intense illumination the patient first sees a positive image consisting of a dark circle surrounded by a bright ring. This is followed by a longer lasting negative afterimage which consists of a small bright circle in the middle of a dark gray ring. The bright circle represents foveal function and it is now stimulated by asking the patient to focus this circle on letters or objects. As the patient brings a letter or object within this afterimage he acquires a subjective recognition of the projection of his own fovea in space and the sensory-motor coordination for foveal fixation.

The perception of the negative afterimage is associated with the function of the highest cortical centers and psychologically has the value of a real object. The fovea in this manner regains superiority over the surrounding retina, and the suppression of foveal function is eliminated. Fixation with the negative afterimage, which represents the fovea, serves to convert abnormal fixation into normal fixation. This, according to Cüppers, is not true of the positive afterimage.

Cüppers' method of treatment is conceded to be the method of choice for breaking up eccentric fixation. The treatment is repeated several times daily for several weeks or months. This form of therapy is scarcely applicable before the child is 6 years old. It is effective in the treatment of amblyopia with or without central fixation. In patients with eccentric fixation treatment is begun by occluding the amblyopic eye for three to four weeks to remove the motivation for eccentric fixation. Such

occlusion also removes the motivation for abnormal correspondence. The amblyopic eye is kept occluded between treatments until alternation is obtained. In some patients with amblyopia the change in fixation promptly produces a rise in the visual acuity of the amblyopic eye, particularly if the foveal scotoma is not too extensive. Most patients, particularly older children, require further training. After central fixation is restored, treatment is the same as for amblyopia with central fixation.

Cüppers' method of therapy found wide acceptance in Europe and had favorable reports from several clinics. From the standpoint of prognosis, the more difficult it is to obtain a negative afterimage, the poorer the prognosis; and the easier it is to obtain it and the longer it lasts, the better the prognosis. To prolong the duration of the afterimage he devised a flashing appliance called a coordinator. Cüppers' method is not easy. It requires great perseverance on the part of the ophthalmologist and patient. The patient has to be intelligent enough to understand what is required of him, and have the desire to cooperate in order to achieve it.

To train sensory motor incoordination Cüppers combines the negative afterimage with fixation on Haidinger's brushes. For this he has a special device. The best results are obtained in patients about 10 years old. Training of binocular vision may begin long before this age. Orthoptic training of itself aids in the recovery of morphoscopic vision. Surgical operation is performed at whatever stage in the therapy of strabismus it becomes indicated. The treatment of amblyopia thus becomes integrated into the general pattern of strabismic therapy. The tendency of amblyopia as well as the other sensory-motor visual anomalies to recur calls for periodic supervision and checkups with reinstitution of treatment well into adolescence.[9]

Bietti's work[2] on the medical therapy of the suppression phenomena in strabismus should be mentioned in this connection even if it does not as yet lead to practical implications. His clinical investigations indicate that it is possible to reduce or eliminate suppression in strabismus by various pharmacologic agents administered internally or by local instillation. He is investigating inhalations of oxygen, benzedrine and strychnine injected or given orally, and strychnine and intermedin instilled into the conjunctival sac. The mode of action is attributed to better oxygenation, and to the prevention of synaptic blockage. He believes that the effect of local instillation on amblyopia indicates that there probably is a local as well as a cerebral factor in the cause of amblyopia.

The psychotherapeutic aspect of amblyopia and the possibilities of psychotherapy are just beginning to be recognized and investigated, and psychotherapeutic approaches to the treatment of amblyopia are foreseeable in the future.

SUMMARY

1. The types of amblyopia are differentiated and the importance of a differential diagnosis between amblyopia with and without central fixation is emphasized.

2. The technique of treating each type is outlined, and new instruments and methods described.

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ORTHOPTIC PRACTICE IN EUROPE

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Orthoptic practice in Europe is similar in many ways to orthoptic practice in America. Recently there has been much emphasis on the treatment of amblyopia, and it is perhaps in this field of pleoptics that there have been the greatest advances. In the management of eccentric fixation the Europeans have been particularly aggressive in the development of various mechanical aids. I will describe some of the instruments and techniques which have been developed, particularly those by Bangerter and Cüppers.

My discussion will include (1) amblyopia with central fixation according to Bangerter's teaching and (2) amblyopia with eccentric fixation according to the methods of Cüppers.

AMBLYOPIA WITH CENTRAL FIXATION

The school of Bangerter,[1] St. Gallen, Switzerland, treats amblyopia extensively by coordinating the sense of vision and other senses. For example, in using the *localisator* (fig. 1) the patient has to find a light which appears on a little board. To make this task easier in the beginning the light is placed underneath a little hole in the board so that the patient can feel the hole over the light with his searching finger, while his amblyopic eye tries at the same time to locate its target; the good eye is occluded. This is particularly important for patients in whom an incorrect localization as well as poor vision exists. When the eye is so improved that the help of the sense of touch is no longer necessary, a glass plate is put over the board and the patient has to rely on his vision alone.

FIG. 1—Localisator[1]

In order to increase the difficulty of this exercise, pictures which have holes corresponding to the different light bulbs may be put between glass plate and desk. Some pictures show but few large objects, while others have a variety of details in which it is, of course, more difficult to find the lights. Further advanced pictures in this series have holes of a smaller size which diminish the intensity of the lights. The holes in all pictures are placed in a sensible way: the light appears in the dwarf's lantern, in a star, and in a lion's eye, etc.

Another instrument is the *corrector* (figs. 2 and 3) which uses the sense

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FIG. 2—Corrector[1]

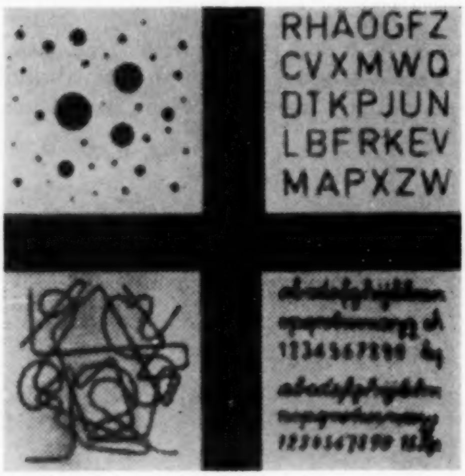

FIG. 3—Plates with different designs for the corrector.[1]

of hearing to support the defective vision. It consists of a desk covered with a metal plate on which various designs (letters, drawings, etc.) are printed in an insulating substance. The patient uses a "pencil" which closes a low electric current as soon as it touches the bare metal, that is, as soon as the patient misses the lines. The closed current produces a humming noise which tells the patient that he is off the track even if the amblyopic eye is not yet able to see small deviations. This also has the psychologic value that other people in the room can hear it; thus the patient's pride will let him concentrate the best he can to avoid the noise. The intensity of the noise can be diminished until the patient finally has to rely on his vision alone.

Another instrument based on the same principles is the *drill* (fig. 4),

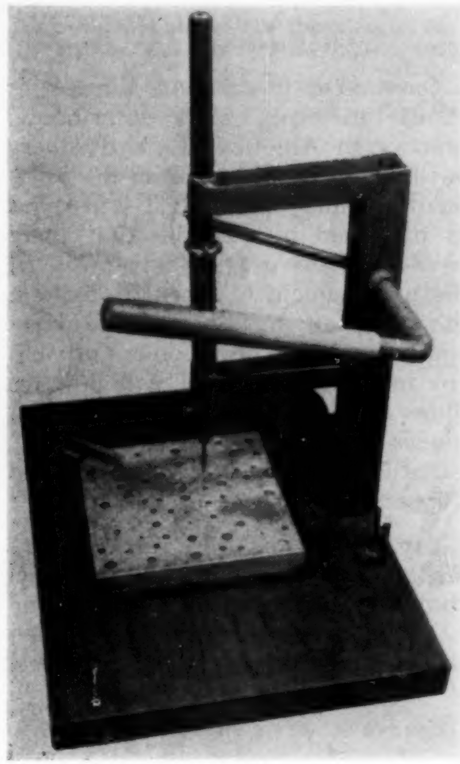

FIG. 4—Drill.[1]

which mostly interests mechanically inclined boys. If they miss the holes a noise can be heard.

Other instruments use the patient's memory to support the low visual acuity. With the *Mnemoscope* (fig. 5) a picture, which the patient traces, is projected on a piece of paper in a size which the patient can easily see with his amblyopic eye. After he has traced the picture it is projected in a smaller size. If the smaller picture had been projected first, the amblyopic eye would not have been able to discern

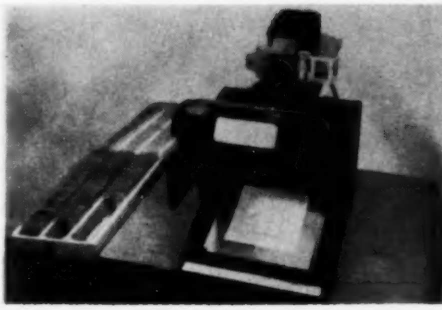

FIG. 5—Mnemoscope.[1]

its details. But since he remembers how he has just seen them in a larger scale, he will be able to trace them correctly. When the amblyopia has been improved the patient will be able to trace the small sized pictures even without having seen them in higher magnification.

The so-called *Mnemoscope trainer for distance* is an instrument which the patients are very eager to work with, since it seems to be nothing but fun. It consists of a movie projector (any 8 mm. film can be used) which may be moved automatically on tracks closer and farther away from its screen. The focus of the projector is changed synchronously to its varying position. If the distance between projector and screen is large, the picture will, of course, be large, and the amblyopic patient (patch over good eye) can easily see the scene. When the projector is moved closer to the screen so that the picture becomes progressively smaller, the patient is still able to see the same figures and is, furthermore, so interested in the action on the screen, that he will do the utmost with his amblyopic eye to watch it. If, after a while, the scene becomes too difficult to follow, the picture becomes larger again, thus renewing the patient's interest.

Another advantage of the instrument is that many patients may watch at the same time, seated at different distances from the sceen according to their amblyopia. A probable disadvantage is that it needs much space, the tracks alone being about nine feet long.

One of the leading characteristics of amblyopic vision is the difficulty in separation. The patient will have relatively good visual acuity when tested with single E's, the so-called "angular visual acuity," but his acuity on a regular E chart will be only about half as good. In order to improve the actual visual acuity to the same level as the "angular visual acuity" Bangerter[1] uses the *separation trainer* (fig. 6), an instrument which shows a large number of E's, all of

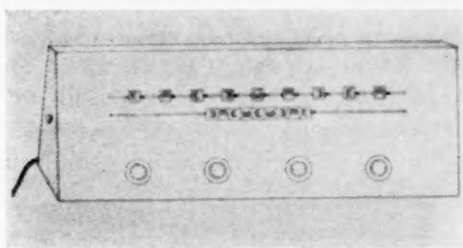

FIG. 6—Separation trainer.[1]

the same size. The distance between E's, which is very great at the beginning of the exercise, can be gradually decreased until it corresponds to a regular Snellen's chart. This gradual decrease in distance helps the amblyopic eye to overcome its particular difficulty. Figure 6 shows a model in which the distance can be changed horizontally; figure 7 shows a model on which the distance between the lines is variable as well.

Some less expensive substitutes for this separation trainer have been tried: Ehrich[3] has the E's different distances apart on slides which are shown by a

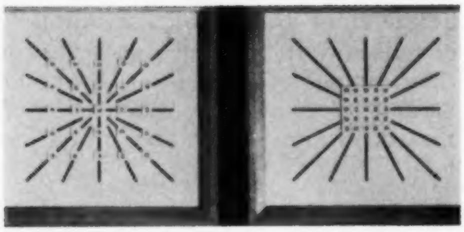

FIG. 7—Separation trainer; interval of symbols variable in two directions.[1]

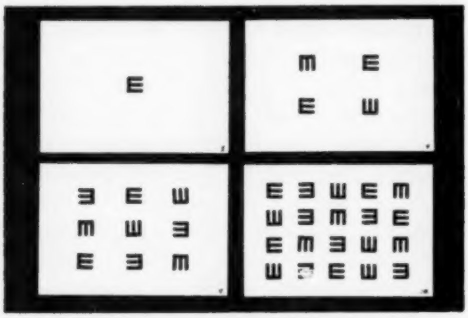

FIG. 8—E's printed in different distances with a rubber stamp.

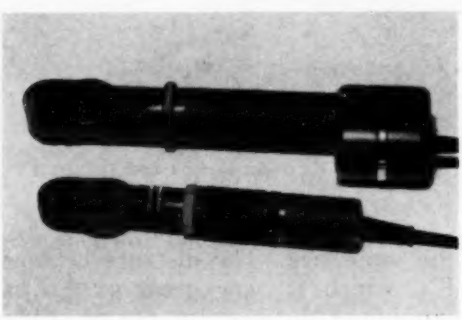

FIG. 9—(Top) Euthyscope; (Bottom) Visuscope. Both instruments are manufactured by the Oculus Company.

projector. I have rubber stamps of E's in sizes of 20/40, 20/30, 20/20. The E's may be stamped on sheets of cardboard at any desired distance (fig. 8). Since (after the purchase of the rubber stamps) it costs practically nothing to make as many charts with as many different distances as one desires, the charts may be given to the patients for home training.

A word about terminology: *pleoptics* in the European usage means all types of training for amblyopia, whether the fixation is central or eccentric. Hence, in European literature the term includes all the techniques described above and the treatment of eccentric fixation by means of an afterimage. In America, however, *pleoptics* is applied only to the afterimage treatment of eccentric fixation.

AMBLYOPIA WITH ECCENTRIC FIXATION

It is well known that an eye with eccentric fixation cannot improve its visual acuity over 20/100 since the anatomy of retinal areas other than the macula does not warrant a better acuity. Cüppers,[2] in Giessen, West Germany, has developed a set of instruments for diagnosis and treatment of eccentric fixation, which has become widely used in central Europe over the last four years. The two instruments used are both basically ophthalmoscopes (fig. 9) with the addition of some diaphragms, projecting certain marks on the fundus that can be seen by patient and examiner alike.

The visuscope has for diagnostic purposes a small star in the middle of its light beam which the patient is asked to fixate. If he fixates foveally, the little star can be seen by the examiner exactly on the fovea. If the patient uses an area other than the fovea for fixation, the little star will be seen on that extrafoveal fixation area (fig. 10). With this instrument we can diagnose small amounts of eccentricity which would escape our notice with other means of examination.

Once the diagnosis of eccentric fixation is made, the second instrument, called *euthyscope*, is used; it projects

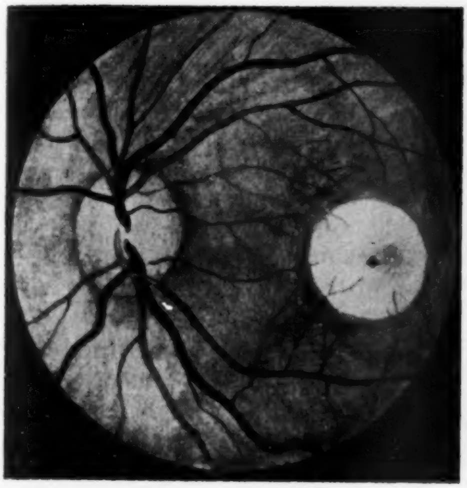

FIG. 10—Image of the star projected by the visuscope as seen in eccentric fixation.

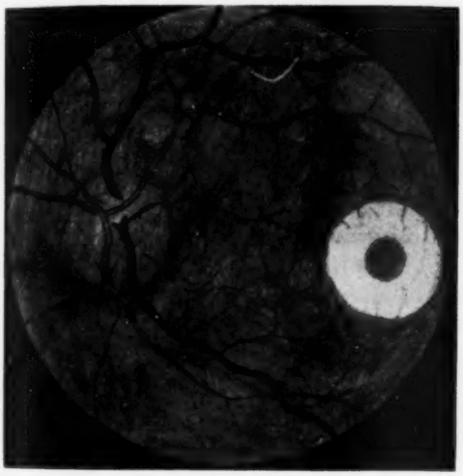

FIG. 11—Perimacular dazzle produced by euthyscope with sparing of macula.

a larger dark dot on the fundus. The dot has to be located so that it covers the anatomic macula (fig. 11), while the area surrounding the macula—and this includes the eccentric fixation area—is dazzled by the light of the euthyscope. After about 30 seconds the patient will have a positive afterimage, that is, a dark dot in a bright field. After a few seconds, however, the positive afterimage becomes a negative one, in this case, a small light dot on a dark background.

The patient is now asked to superimpose the dot of his afterimage with a target in the room, e.g., the symbol E. As soon as he is able to do so, he is actually fixing foveally. It is important that the afterimage is negative because only through the light dot is it possible to see another target.

Furthermore, the negative afterimage has more the character of an object and has a higher mental value. One simple experiment will demonstrate this: an afterimage of a circle seen against an inclined surface will appear as a circle as long as it is positive, but will appear to be an ellipse when it becomes negative. The negative afterimage undergoes the same distortions as a real object. The fact that it is mentally regarded as a real object facilitates the reorientation for the direction "straight ahead" from the pseudomacula to the anatomic macula. In order to prolong the time in which the afterimage is visible, Cüppers uses an automatic switch for the room illumination which changes from light to dark in intervals of seconds (variable). Longer dark periods accentuate the negative afterimage.

During the course of treatment it can be observed with the visuscope how the point of fixation is shifting towards the macula. This occurs gradually in some patients; the fixation area is a little closer to the macula after every treatment. More frequently, it shifts suddenly, e.g., after one session thé little star might be found in the macula but a few minutes later it is back to its old place; consecutive treatment will then have to stabilize the macular fixation. During the entire period of this treatment the amblyopic eye should be patched in order

not to give this eye any chance to use the pseudomacula at all. The patch on the amblyopic eye is well tolerated by all patients.

Recently Cüppers has been using Haidinger brushes in combination with the afterimage.[4] Naturally they can be perceived only by macular fixation.

The results of this treatment have been very promising. Good cooperation of the patient is essential. After foveal fixation has been firmly established the treatment proceeds as in any case of amblyopia with central fixation. Thus the major amblyoscope is used in the same way as it is used in the United States. Indeed, this device is still the most important single orthoptic instrument, not only for eliminating suppression in amblyopia, but also for increasing fusion amplitude and overcoming anomalous retinal correspondence.

COMMENTS

Orthoptics in Europe has been influenced by the economic status in the different countries and by the highly socialized medical practice. The average worker cannot afford a private physician and expects his state-controlled insurance to cover these expenses. Under this scheme of socialized medicine the compensation for each patient is very small and therefore most of the orthoptic work is carried out in the large university clinics. That fact naturally causes many problems: many patients live far away so that visits twice a week or more often are impossible.

In St. Gallen, Switzerland, this problem is solved by hospitalizing the patients for a period of several weeks. They have wards, separated from the main hospital, so that the young patients live there as they would in a kindergarten rather than in a hospital. Treatment during this period of hospitalization is as intensive as possible and many of their good results might be attributed to that fact.

In Vienna, Austria, where Bangerter's principles are followed very closely, hospitalization for the sole purpose of orthoptic treatment is not possible, and for out-of-town patients, arrangements are made so they can stay with relatives or friends in town for several weeks.

In the European clinics much of the routine work in orthoptics and pleoptics is done by resident ophthalmologists rather than by orthoptists. Most of the ophthalmologists doing this type of work are women who seem particularly suited to treat children. This creates an unusual situation in many clinics with the same ophthalmologist-orthoptist handling the various aspects of the problem including general ophthalmic examination, refraction, orthoptic treatment, pleoptics, and, in many cases, surgical treatment. This obviously affords a continuity of treatment available in no other system.

A disadvantage of this arrangement, however, is that most of these physicians spend only a relatively short period during their residency in this field of orthoptics. Such a resident in ophthalmology cannot be expected to have all the experience and finesse in the field of orthoptics that an orthoptist acquires during many years of successful practice.

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THE SECOND IMAGE IN ORTHOPTICS

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Normal human vision is binocular. Two images are transmitted to the brain for interpretation. Images from the horopter received on corresponding areas are fused, or if the disparity is within the areas of Panum stereopsis is perceived. In order to see with the greatest visual acuity the eye must fix in such a position that the image falls on the retinal area of best acuity; in the normal eye the image falls on the macula, or the fovea for minute perception.

With a little practice the infant learns that when the two eyes are properly coordinated he gets a single clear image from the two maculas. He also becomes aware of diplopia if one eye fixates an object and the other eye receives the image of the same object on a noncorresponding area. If he is fortunate, all his life he will be able to fixate with both eyes on the same object and get the two images on the maculas and let the brain fuse the images.

In the presence of strabismus, or intermittently in heterophoria, he finds that when one eye fixates, the other eye receives the image on a noncorresponding area and the brain cannot fuse the two images. He must either suppress the second image, project it in an anomalous direction, or tolerate the intolerable, diplopia.

If he suppresses, he no longer has binocular vision. He may grow to maturity without awareness of diplopia, including physiologic diplopia.

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The first step in restoring normal binocular vision is to restore perception of the second image. To achieve fusion the images must be located on corresponding areas, either by moving the eye to the correct posture, or by moving the image as by prisms or haploscope so that the second image falls on the area of correspondence.

Since the horopter changes on casual seeing, a surgical setting of the eye cannot establish a correct location for all distances fixated. Neither can a prism give constant correction. Nothing can replace the need for the patient to exert some muscular effort to get and keep the images correctly placed. If he cannot exert such effort he must either suffer diplopia or use suppression or anomalous correspondence whenever the situation is different from the fixed relationship established by surgical treatment or prisms.

Orthoptics consists of establishing perception of the second image and developing vergence control. Endurance in controlling the images is the final orthoptic goal.

The orthoptic steps to fusion success are: (1) to arouse perception in the nonfixating eye, (2) to develop recognition of the location of the secondary image, and (3) to help the patient improve the location (move it within fusion range) to the limits of his ability.

To perceive a second image the patient must be able to recognize that a first image exists. Each image must have identity. There must be no confusion between a first image

occurring twice and a different, second entity to be perceived and described. This word *describe* is important because perception is subjective and we do not know what the patient perceives unless he describes by word or gesture something about his perception. Thus the techniques for establishing a second image must be a combination of helping the patient perceive it and enabling him to indicate to us its presence and location.

Three principal techniques available to help the patient perceive are light, motion, and the character of the image, such as color, size, and form. By creating a bright second image we make it hard to suppress, but if both images are bright we fail in the need to create a different identity for the second image. This is the kind of a dilemma which exists when we try to arouse diplopia by fixation on a bright light. If the patient alternates, he has a sense of "twoness," first one and then another one, which is not diplopia, not binocular perception, but merely alternate perception. The same thing may happen when looking at a red button or similar fixation material. There is no clue to the characteristics of the second image and if he is aware of "twoness," he thinks he has achieved diplopia and will not work further to attain it.

The simplest way to secure differentiation of the two images is by use of a red filter over one eye. With a white fixation object, light, button, or picture, the patient can be shown two images strikingly different in character depending upon which eye is fixing. The young child may need to be instructed in the use of the word *two* to describe diplopia and not alternation. This is easily done by using two pencils, a red one and a white one, holding up one at a time and then both and teaching the use of the words *red*, *white*, and *two*. (Not red-and-white which could mean first red and then white, or alternation. The words *red and white* can be a serious pitfall and I avoid it by never, at any stage of training, permitting this phrase.)

If the patient cannot fixate steadily enough on either the red or white to permit perception of a second object, he needs practice in just this stable fixation with one eye before he is ready for binocular perception. If he fixates steadily but still does not perceive a second image he may be able to perceive a second color. This is especially true if he fixates "red" and notices "white" out of the corner of the nonfixating eye. The patient may be drawn to the wall or window (but no change of fixation permitted) so that some gross area is perceived as "white" while the "red" eye fixates. A suppressing eye does not behave like a blind eye, and crude perception of "other color" has proven uniformly successful, provided the patient does hold fixation with the "red" eye. Another technique is to fixate "red" while a second, white object is brought from behind the patient's head into the field of vision of the non-fixating eye. The patient is asked to report when he sees it and whether it is "white." This is not diplopia, but it is a crude form of binocular perception.

The next step is to get two colors on the same area; at first a large area such as an 8 x 10 page is held two feet from the eyes. If there is a picture on the page (painting book) the strabismic patient should perceive diplopia. He usually sees two colors but suppresses the form (drawing) of the second image. He frequently describes the page as half

red and half white, anatomically impossible but the beginning of binocular perception. As this perception stabilizes (it is very fleeting at first) the patient can learn to report "where the red stops" on the page as a pencil pointer is moved across. Eventually a simple marking such as a spot or cross can be perceived as "two." Older children can notice alphabet cards as "printed twice." The fixation page is gradually decreased in size to whatever area the patient's deviation indicates is practical for diplopia without the second image moving off into space.

Binocular perception at near is followed by binocular perception at distance. The fixation material is posted on the wall and the patient learns to hold two colors, and later two images, while he walks backward. The television screen is also useful at this point in his training.

At the same time that his awareness of two images is being stimulated, his judgment of location (projection in space) is carefully trained. Not all errors of location in space are due to anomalous correspondence. Much more often they are due to the transitory character of such images, giving the patient too little time to make accurate judgments about location. He "guesses" or tries to "remember where it was" after it is no longer perceived. In the presence of alternation the patient always "guesses" wrong. This is a great help to the technician, who can feel sure that if the second image is wrongly located it is not in existence. Close inspection of the patient's eyes will show a loss of fixation just before, or while, he is making up his mind about what to say. In well-established cases of anomalous correspondence there will be two images from the nonfixating eye, one correctly located and the other too close to the primary image. The patient needs to be coached to disregard the anomalous image.

When the patient has good awareness of the second image by means of the red filter, he is taught to hold it while the filter is removed. Subsequently he learns to recognize diplopia without the help of the red filter.

While this practice in perception is being carried out, the patient should also receive instruction in the controlled situation offered by the major amblyoscope. This is especially efficient because it is possible to use two images of very different character so that there need be no confusion about which one is being described. These simultaneous perception targets cannot be fused. They can only appear "fitted," when projected in the same direction, and "apart" when in different directions. If one image is suppressed (no matter how fleetingly) it has *no* relationship to the image which remains perceived, simply because it does not exist.

The technician must be sure that the conditions are right for the perception of a second image before the patient is asked to report on it. Even with the conditions objectively correct, the patient may be suppressing and not perceive a second image. If pressure is put on him to report about it he feels that he must make some sort of statement, and if there is no fact to report, he has to guess or imagine, which is not the kind of "evidence" that is helpful to diagnosis and efficient treatment. It takes time to observe and evaluate and report upon a situation. Hence, the patient must perceive the second image with sufficient stability to make up his mind and report on it. The time interval necessary varies widely with

the difficulty the patient has in perceiving and with his maturity in making responses.

To get a prompt, accurate, response the technician must be sure the patient has an adequate vocabulary for describing what he sees and uses his words with the meanings she intends. There are many semantic pitfalls in words like *two* and *in*. Since simultaneous perception may be present but very fleeting, long, wordy phrases are often inaccurate because the situation has changed before the statement is completed. Questions should be framed in such a way that the patient needs to make only a quick *either-or* or *yes-no* decision.

There are three stituations the patient can perceive while looking at simultaneous perception (SP) targets: they fit, they do not fit, or one is out of sight. If they fit or do not fit the patient does perceive a second image, but if he is suppressing he has no second image and is much lower on the ladder of binocular vision. In the absence of a second image he is not ready for any kind of vergence control.

Failure to perceive a second image is the commonest cause of orthoptic failure. It prevents breakdown of alternation and vergence control in monocular strabismus, especially low degree esotropia and high exotropia. No pains should be spared to find out reliably whether the patient perceives a second image and hence is ready to locate and control it, or whether it is absent from his consciousness and is only imagined, imitated or guessed.

The best objective clue to perception is the posture and stability of the fixating and nonfixating eyes. In the absence of stable fixation of one eye the other eye has no opportunity to receive a second image for perception in the brain. If the relationship between the two eyes is unstable it is, by definition, ill-defined, and the patient cannot give it identity and location. If the patient is not *collecting* facts about a second image, he cannot be expected to *state* facts.

It must not be assumed that when a patient makes a statement that it is true to fact. It is often assumed that a patient has anomalous correspondence when he says the "baby is in" and the second image is off the fovea. He is not necessarily seeing the baby "in" (projecting the baby image in the same direction as the crib). He may be alternating and trying to remember where the baby "was," or guessing where he "might be."

To help the patient report correctly it is useful to teach him that "out of sight" is an acceptable statement if it appears true to the patient. If asked where the baby is, few patients spontaneously think it is appropriate to say out of sight; they think they must report some kind of definite whereabouts. Moreover, most patients "find" the baby so easily by alternating, that they do not realize that it is ever out of sight.

Stable fixation on one image makes it possible to find out whether the second image is really present, and then to locate it. First attempts at location may be very gross, as on "this side" or "that side." Progress can be gradually made toward "touching the crib" and finally "in the crib" if suppression does not persist.

Since SP targets are highly artificial, it is important to collect evidence about actual fusion skills as soon as possible. This is difficult because, to the patient, the single image of fusion looks like the single image of suppression. Only the check-marks are different. Hence, great accuracy in reporting the presence or absence of check-marks is vital for accurate

diagnosis. The check-marks must be suitable for quick, reliable observation and the patient must use quick, accurate words if he is to report correctly on rapidly changing situations. Patients, just because they are orthoptic patients, are usually very inexperienced in fusion and are immature in fusion perceptions, whatever their ages.

Check-marks vary in location, size, color and in importance to the appearance of the picture. They should be selected for the purpose in mind. For encouraging stable fixation, laterally placed check-marks are a poor choice. They make the patient feel he must look to the side for observation of the check-mark and lose fixation. On the other hand, central check-marks may be in the area of deep suppression. Large check-marks are not easy to suppress but give no clue to the existence of small suppression areas, especially the fovea. Some check-marks are so extraneous to the character of the picture that children have difficulty in attending to them. Others are so difficult that the patient is discouraged from attempting to perceive them.

Fewer patients develop peripheral suppression than central suppression. It is not so important for casual comfort. Hence, any techniques that encourage peripheral perception are most likely to be successful in giving *some* awareness of binocular perception. The psychology of success is important in orthoptics. The patient should be given a task which is a challenge and yet within his ability.

If the normally fixating eye is directed to fixate, the deviated eye is experienced in suppression and will have great difficulty perceiving the second image. If the usually suppressed eye is induced to fixate, the other eye is not expert at suppression and will more readily perceive diplopia. This is true with and without the use of the amblyoscope.

If the importance of the second image is admitted and the techniques for establishing it attempted, but the problem remains, are the methods successful? Does the patient truly perceive a second image? Is it projected normally? If true, progress proceeds to vergence control. If not true, exposure to situations requiring vergence control are futile.

Some patients attain such a good status from refraction and surgical treatment that the second image is established spontaneously. They may need orthoptic help in vergence control only, or in accomodation-convergence balance, or none at all. Their learning process in binocular skill may proceed with little or no supervision. Such patients have rarely come to my attention. I nearly always find remnants of visual conditioning which, despite excellent ophthalmic care, prevent spontaneous perfection of normal visual habits.

If the objective status of the patient is such that he *should* be fusing, the best test of his subjective status is physiologic diplopia. In the presence of suppression the patient has a single image such as he would have if he fused. He must check on his status by some means other than inspection of the fixation object. A bar for physiologic diplopia practice is most convenient. Since normal eyes are adept at suppression of physiologic diplopia and other distracting images, a good deal of coaching is often necessary to teach a patient to report correctly on physiologic diplopia such as bar framing or bar reading.

To teach recognition of physiologic diplopia it is often helpful to demon-

strate that if one eye is suppressed (or covered) the single bar is solid, and "hides something." Physiologic diplopia (for near, fixation at distance) gives *two transparent* bars. In bar-reading practice the patient should be required to report (read) what is seen "through the left bar," etc.

There is the problem of the patient who claims diplopia, which he usually describes as "seeing double." His status must be analyzed to find out whether he is seeing a second image, or the same image in two different places. The images must be differentiated, as by a red filter, and the patient indoctrinated with the idea that "out of sight" is an acceptable situation, before a discussion of the actual presence of a second image can be discussed intelligently.

Orthoptics should be directed at the patient's disability. Nature has ordained the skills of fusion. They consist of the motor reception of two images maintained on corresponding areas for different distances and directions of gaze, plus the sensory interpretation of them as disparate, fused, or stereoscopic. If the patient is not so fortunate as to learn spontaneously he must be taught how to discover his errors and correct them. Nature's signal of error is diplopia. We have not invented a better tool. We can only restore perception of it to patients who have become conditioned to ignore it.

CONJUGATE OCULAR MOVEMENTS IN CATS AND HUMANS

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FOR several years a small group of investigators at University of California at Los Angeles has been engaged in a study of the central nervous system and its role in control of eye movements. Experiments were designed to determine which parts of the central nervous system were critical for the performance of normal conjugate ocular movements, and where lesions might be placed which would result in particular defects resembling certain clinical syndromes. Although a human being has the advantage of communicating about diplopia and other symptoms of abnormal ocular motility, there are certain experimental procedures which can be carried out more readily on lower animals. For example, one can stimulate a part of the brain of an animal through an electrode inserted into the nervous system, but it is difficult to get human volunteers for such experiments.

We have devoted considerable effort in the last few years to determining the best method of obtaining conjugate ocular movements in an experimental animal, to describing these movements as accurately as possible, and to determining their reproducibility from animal to animal. It has also been felt necessary to compare the experimentally induced eye movements with some type of normal human eye movement for unless there were similarities between the two types of movement we would feel it impossible to extrapolate any experimental results to the human.

For the animal experiments the cat was chosen. In all cats of average weight, the shape of the skull and brain is so similar that stereotaxic techniques[10] can be used for accurate placement of electrodes in small, deeply placed structures such as the oculomotor nucleus. Monkeys, which are closer to humans than are cats, were not used for two reasons: they are much more expensive, and they exhibit much more convergence. For preliminary studies we felt that conjugate deviations or versions were sufficiently complex without the added factor of vergences.

Numerous investigators in the last 80 years have evoked eye movements by electrical stimulation of different parts of the brain. Electrical stimulation is a useful tool because the intensity can be graded and reproduced at will. Using this method of evoking eye movements, the first two problems we faced were the making of maps of the brain stem showing which areas yielded conjugate ocular movements on stimulation and which did not, and the finding of the best preparation (with or without anesthesia) to use for further studies.

The brain stem, extending between the spinal cord and the cerebral hemispheres, was selected as the first part

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of the nervous system to study for two reasons. First, the final motor nuclei (III, IV and VI) innervating the extraocular muscles are situated within the brain stem. Second, "centers for conjugate gaze" have been postulated by many authors, and most of them have been located in some part of the brain stem. Cogan,[3] for example, describes a "pontine center for lateral gaze," and discusses the superior colliculus as the probable "center for vertical gaze." Other authors offer these or other regions of the brain stem as coordinating centers for gaze in one or another direction.

In our first experiments the brain stem was systematically mapped in four feline preparations to determine the areas yielding conjugate eye movements in response to electrical stimulation. In cats anesthetized with either Nembutal or chloralosane, conjugate deviations were obtained from only a few small regions of the brain stem.[9] In the unanesthetized cats, however, stimulation of sites in widespread brain stem areas yielded coordinated movements of the eyes.

Of the unanesthetized preparations, the encéphale isolé[9] was selected as preferable to the decerebrate[5] because its higher centers are intact. (To prepare an encéphale isolé, the spinal cord is sectioned at a high cervical level under ether; when the ether effects are over, the animal, now unanesthetized, remains quiescent and apparently with no pain for the remainder of the experiment.)

In the feline encéphale isolé, spontaneous movements of the eyes are varied; sometimes the eyes move conjugately, and at other times they assume a dissociated or disjugate position. It is thus possible to stimulate a particular brain stem site several times, with the eyes in different initial positions. Watching the eye movements obtained under these conditions suggested that the movements were "goal-directed"; that is, the eyes always moved to the same final position on repeated stimulation of the same brain stem site, regardless of the initial position and its directional relation to this final position. Thus movements of different direction, but to the same goal, could be evoked by stimulation of a single site.[9] Since current concepts of coordinating centers are in terms of movements in specific directions,[3] the preliminary finding of "goal-directed eye movements" indicated a possible need to redefine the concepts in terms of the position of the eyes at the end of a movement rather than of the direction they traversed to reach this position.

At this point more accurate information on the characteristics of eye movements evoked from the brain stem seemed necessary. Motion picture recording of the eyes offers an objective method for determining the position of the eyes at any phase of a movement, and also yields information on the speed of the movement in terms of distance traveled by the eyes in a unit of time. From analysis of motion pictures it was found that repeated stimulation of any one site, in each of several regions of the brain stem, caused the eyes to assume the same final position with a high degree of accuracy.[4,7] The anatomic location of the stimulating electrode was the major factor determining what this position of gaze would be with respect to the animal's visual field,[9] although alterations in the intensity of stimulation could shift the position within the same quadrant.[8]

The speed of the eyes in responding to electrical stimulation of certain

brain stem sites in the feline encéphale isolé was found to follow a characteristic pattern. Typically, when the stimulus was turned on, the eyes started moving, and rapidly reached a maximal velocity. This rate of travel was maintained only briefly; the eyes began to slow down, and moved more and more slowly as the final position was approached. The time spent in increasing speed was much less than that spent in slowing down, so that the resulting graph of velocity as a function of time presented a "skewed" or asymmetrical shape.[8]

While the eye movements evoked in our cats appeared to resemble the saccadic movements seen when humans voluntarily change fixation, we wished to determine how similar the two types of movements really were. A search of the literature on human saccadic movements revealed that not all studies of the speed of human eye movements are in agreement. Several descriptions of the velocity function can be found, which fit several completely different shapes of curves:

(1) Adler[1] describes the velocity as fairly uniform; this would result in a velocity function resembling a curve with a broad *flat* peak.

(2) The velocity of a saccadic movement was found by Westheimer to resemble a modified *sine* curve[11]; he interpreted this to indicate that a saccadic movement results from a single simultaneous change in the innervation of the extraocular muscles causing the eyes to assume a new position in the orbit dictated by the resulting change in muscle tension.

(3) The illustrations of Brockhurst and Lion[2] show a *skewed* velocity function, in which acceleration occurs in a shorter time than deceleration. The shape of this latter curve resembles that which we found for the eye movements evoked by brain stem stimulation in cats, and corresponds to Adler's description of simple muscle actions.[1]

In view of the variety of velocity functions for human saccadic movements available in the literature, we wished to compare the velocity of human and feline eye movements using the same recording technique for each. Accordingly, a study of human voluntary saccadic eye movements was undertaken.[6] Ten adults were asked to look as rapidly as possible back and forth between two fixation targets, while their eyes were photographed at high speed. With the targets separated by an angle of 30 degrees, measurements of the distance of pupillary movement from film frame to frame were obtained. These yielded a skewed or asymmetrical velocity function: when moving from one fixation target to the other, the eyes rapidly increased in speed to a maximal velocity which was not maintained; the eyes began to move more slowly, and continued to slow down until the end of the saccade.

The skewed shape of the velocity curve for human saccadic movements resembled the asymmetrical velocity functions found for brain stem evoked ocular movements in the encéphale isolé cat. The curves are similar to those found by Brockhurst and Lion[2] with a different recording technique. Both human and feline velocity functions of asymmetrical shape support Adler's description[1] of how one would expect the eyes to move on the basis of simple mechanics of the extra ocular muscles.

How is the speed of the moving eye adjusted to compensate for movements of different distances? In theory adjustment of speed to distance could be made in one of several ways.

For example, (1) the eyes might achieve a maximal speed which was the same for any distance, but this might be maintained for longer times with longer distances; or (2) the maximal velocity might be so much greater with longer distances that it fully compensates for the distances; (3) partial compensation for increased distance might be obtained by an increase in the maximal speed and the remainder by increasing the total time of the saccade.

Adjustment of speed to distance for the electrically evoked eye movements in the encéphale isolé cat was found to conform to the second theoretical type. That is, with repeated stimulation of one brain stem site, the eyes took the same amount of time to reach the final position characteristic of this site whether they had been near or far from this position at the time the stimulus was begun.[4,8] Thus all compensation for increased distance was made by an adjustment of velocity.

In the case of human voluntary saccades, however, the adjustment of speed to distance corresponded to the third theoretical type. Both the maximal velocity and the total time of ocular movement were increased with increasing separation of the fixation targets.[6]

It is not surprising to find a difference in adjustment of speed to distance in two so dissimilar types of ocular movements as those studied. Cats and humans have certain differences; an encéphale isolé is not like an intact organism; electrical stimulation is artificial compared with voluntary activity. Experiments can be designed to determine which of these factors is responsible for the differences observed in relation of velocity to distance of a conjugate eye movement. Quite possibly the most important difference in the two types of movement described is the difference between electrical stimulation and voluntary activity.

It is perhaps surprising that ocular deviations evoked by electrical stimulation of the nervous system have any resemblance to conjugate movements of an intact organism. After all, the method of electrical stimulation is unphysiologic in the sense that the stimulus activates a large population of neurons to discharge synchronously whereas normally a discharge is apt to be asynchronous. That there are resemblances is encouraging, since an experimental preparation like the feline encéphale isolé affords opportunities for surgical and pharmacologic manipulation of the oculomotor apparatus which are impossible in the human. It is to be hoped that studies on this and related preparations may one day lead to a better understanding of some of the defects of ocular motility so frequently observed in the clinic.

In conclusion, some of the characteristics of ocular movements evoked by electrical stimulation of the brain stem of the encéphale isolé cat have been compared and contrasted with characteristics of human voluntary saccadic movements. While there are certain fundamental differences in the two types of eye movements studied, it is felt that the conjugate ocular deviations of the cat, which can be evoked under controlled conditions, exhibit evidence of central nervous coordination which makes this preparation a valuable tool for increasing understanding of the basic mechanisms of ocular motility in man as well as in lower animals.

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THE COMMON POCKET MIRROR AS AN ORTHOPTIC INSTRUMENT

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THIS paper should be of special interest to the ophthalmologist who does not have an orthoptist and who does not have a major amblyoscope. I will explain how the common plane mirror can be used to study the binocular status of a young patient.

The mother stands in front of the child; the ophthalmologist stands to the side of the child on the side of the strabismic eye. The child is given a plane mirror to hold in front of the strabismic eye and is shown how he can make the image of the ophthalmologist move back and forth, and up and down out in front of him. Then he is told to move the image of the ophthalmologist so that it appears to be in the place where his mother is standing; when the two images are superimposed, he says "Now."

The ophthalmologist watches the fixation of the eye in the mirror and the mother watches the fixation of the other eye. If necessary, each observer can shine a small flashlight into the eye he is observing in order to be sure of the fixation. The light should be held near the line of vision of the observer. The child may also try to fuse the two lights. Various targets can be used by the ophthalmologist and the mother, but one target must be the mirror image of the other. If the mother is not a reliable observer a nurse can replace her.

Several reactions can be obtained. The child may be completely unable to see the ophthalmologist with his strabismic eye as long as his fixating eye is open. This child has deep-seated suppression and will not see double after surgical treatment.

Anomalous retinal correspondence is indicated when the strabismic eye is not fixing on the ophthalmologist at the time the child says the two images are together. It is difficult to determine the difference between harmonious and unharmonious retinal correspondence by this simple method.

When the child has normal retinal correspondence, both the ophthalmologist and the mother know the child is fixating on them when he says the images coincide.

Macular and perimacular suppression is denoted when the image of the ophthalmologist disappears just as it should coincide with the image of the mother. Suppression can occur with normal retinal correspondence and with both types of abnormal retinal correspondence.

Patients with alternating strabismus who rapidly change fixation make the examination more difficult.

If retinal correspondence is normal, home exercises with the mirror can be given to massage the macula and combat suppression. Convergence insufficiency can be treated by convergence exercises. A simple method is to use two milk bottles, one in front and one to the side of the patient. A vertical line is placed on one bottle

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and a horizontal line is placed on the other. The distance of the bottles to the eyes should be equal and the bottles should be at the same height. The mirror is moved from a lateral position medially until the bottles fuse and a cross is seen on the single image. Then the mirror is moved further in the same direction with the patient holding fusion by converging the eyes.

Ingenuity must be used to hold the interest of the patient. Television has been used with polaroid screens and with red and green filters. Still another method is to use two television sets placed facing each other, one on each side of the patient. The patient looks into two mirrors arranged in the same manner as a stereoscope used for viewing roentgenograms. The mirrors are fixed to form a 90 degree angle. The mirror holder can be moved forward or backward to obtain fusion. One third of each set is occluded.

I have found the single mirror a quick way to learn a great deal about how the patient uses his eyes. The mother with normal binocular vision is startled to learn that her child cannot do what seems to her to be a very simple thing.

ORTHOPTIC VARIATIONS

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THE orthoptic precepts presented in this paper are not new, but I have found variations of the standard problems. The problems discussed in this paper include: (1) The loss of convergence and accommodation following head injuries, (2) fatigue of accommodating muscles, and (3) intractable cases of abnormal retinal correspondence.

PROBLEMS AFTER HEAD INJURIES

How often have you heard the patient who has been a victim of a head injury or whip-lash injury described as "neurotic" or "malingering"? His symptoms are vague and disconnected and frequently related to obscure visual problems. During the past year we have had over thirty of these patients referred to our clinic and consequently have spent a great deal of time in medical libraries trying to locate specific literature on the condition. We searched under the titles of "head injuries," "whip-lash injuries," and "concussions." One interesting article written by a U. S. Naval doctor describes the loss of accommodation experienced by many service men who suffered concussions resulting from bomb blasts; but no mention was made of loss of convergence.

Dr. John Gipner reviews in detail all the ocular symptoms of head injuries, including pupillary changes and subsequent death. He also briefly mentions "precipitated presbyopia" and recession of the near point of convergence.[1]

I found only one comprehensive piece of literature on the results of head injuries.[2] The speakers at this symposium had a great deal of material in their World War II records from which to draw. In this book a discussion of the loss of depth perception was interesting and Dr. A. G. Cross deals with the loss of accommodation and convergence at considerable length. He describes the loss as very common. He states that:

> Most cases show equal defect of the two functions (convergence and accommodation) but occasionally either may be deficient separately. Spontaneous recovery occurs in some of these patients but the process is hastened, and in other cases brought about, by orthoptic treatment. The rapidity with which cure may occur under treatment is an indication of the absence of organic cause and of the functional nature of the defect.

The majority of our patients have been victims of "whip-lash injuries": the result of being struck, usually from behind, while riding in a car. When this great force strikes, the head is lashed forward and then backward. The result of this whip-like action on the neck may range in severity from only temporary stiffness to permanent disability or even death. Sprain of the ligaments and capsular structures of the cervical spine is caused and the sympathetic nervous system is the most likely to be interrupted because of its vulnerable position in the cervical region.

Our particular interest in these patients has been due specifically to a

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notable loss of convergence which was the one common symptom in the majority of our patients. It appeared after injury with no previous record of ocular symptoms. The incidence of loss of accommodation was not quite as high, and although most of these patients experienced a constant loss of accommodation, in two cases the ability to accommodate was intermittent, fluctuating from one moment to the next.

Fourteen months ago a man's car was struck in the rear while he was driving. Since that time he has worn a neck brace and is still receiving therapy for the neck injury. For the first six months he experienced constant throbbing in his head and eyes. Since then he states that his ocular symptoms have been "an intermittent sensation of pressure or squeezing" in his eyes. These symptoms are probably associated with his still-damaged neck ligaments. However, he also stated that immediately after the accident he could not read small print. This symptom was described in Dr. Gipner's article as "precipitated presbyopia." This patient was 43 years old and could expect a gradual onset of presbyopia over the next ten years; the injury caused an overnight aging.

His main ocular problem now is that he "must focus" to locate anything he wants to see. He is an accountant and is trying to continue full-time work. Examination revealed insignificant muscle imbalance: none for distance and seven diopters of outward deviation for near. He had constant crossed diplopia at near due to the fact that his near point of convergence was three feet. (He did not realize that diplopia was present. During testing he stated that he saw only one image but admitted that he also saw "a reflection over there." This is true of many adults although children readily recognize diplopia.)

Fusion was at zero on the troposcope, with a normal amplitude of divergence but absolutely no convergence.

Only 3 of 32 patients have had an excessive amount of exophoria. The usual amount varied between two and ten diopters. One diopter of hyperphoria was present which fluctuated from left to right.

One of the important questions in this type of injury case is, "What was the patient's binocular visual status before the accident?" No previous ocular records were available and therefore the only clues we had were the presence or absence of fusion and the amount of suppression present. For example, another 43-year-old man was referred to us after an industrial accident that included a whip-lash injury. Since the Workmen's Compensation Board was involved, it was important to try to determine if the accident had caused the constant diplopia that was present at near. No deviation existed for distance, but twenty diopters of exotropia were present at near. On the troposcope he demonstrated only weak fusion, and no simultaneous perception was found. He had alternate suppression at his angle of deviation. Since the accident had occurred only three months before, it was unlikely that, at his age, he had developed so much suppression in such a short time. Also the amount of outward deviation at near was excessive. We, therefore, presumed, that probably the condition had been aggravated, but not caused, by the accident.

A similar case was that of an elderly woman who fell and suffered a concussion. Four weeks later she still had an exotropia of twenty diopters at near

and alternate suppression when convergence broke. Consequently, we presumed the condition had existed before the fall. Of course, some foveal suppression was found in other cases but no more than one usually finds in many normal adults with latent deviations.

One interesting case was that of a young woman who tripped over a curb and fell on her knees. She did not bump or knock her head in any way and yet has been suffering from ocular symptoms similar to those of a whip-lash case. It is possible that the fall had somewhat the same effect as a whip-lash, that is, her head was jerked first in one direction and then in the other.

Now, with regard to orthoptic treatment of these patients, most of the patients responded rapidly to simple convergence training. An average of six treatments at the clinic and conscientious home exercises relieved the symptoms, returned convergence to the near point to normal, regained accommodation, and maintained constant single binocular vision.

Four patients definitely did not improve. Two of these were elderly patients who appeared to be unable to understand and carry out any instructions given them regarding home exercises. The other two patients had severe whip-lash injuries and the damage to their neck ligaments is such that they suffer intensely from headaches and are therefore unable to respond to orthoptic treatment at this time.

Three cases proved to be unusual. One concerns a woman in her early thirties who is still wearing a neck brace after 18 months. Although her convergence and accommodation responded easily to treatment, she finds that if she fails to do her home exercises, which are merely divergence and convergence with stereoscopic cards, the ocular symptoms return immediately; she continues to do them daily. She also suffers from photophobia which has not diminished with time.

The second unusual case concerns a state patrolman, 50 years old, who was injured six months ago. Although he is not in a neck brace, it is necessary for him to have physical therapy twice weekly for his injured neck. Between these treatments the discomfort gradually increases until he is in considerable pain; his ocular symptoms increase accordingly. We are working in conjunction with the physician who is supervising the therapy and the patient now comes to our clinic immediately after his physical therapy. In this way he responds more readily to orthoptics. Although he slips back somewhat between treatments as the neck pressure builds up, he appears to be gradually gaining more and more control of his convergence and accommodation.

A 26-year-old man was referred to us two months after his whip-lash injury. He had no deviation for distance but an eight-diopter exotropia for near with constant diplopia. His near point of convergence was twenty inches. Response to treatment was rapid and after six visits to the clinic his convergence was normal. However, six months later he returned. In the interim he had decided to give up his work and return to the University. The added ocular burden of almost constant close work caused an immediate breakdown of his convergence and accommodation. He has again started orthoptic treatments and is showing improvement, but time is necessary to see the end result of this case. So far, he is the only patient who has returned.

I have grouped all these patients with head injuries and whip-lash injuries under one classification as they appear to suffer from a common complaint, that is, loss of convergence and accommodation, the actual cause of which is apparently still uncertain. Naturally many of these patients are of special interest to insurance companies and compensation boards and the matter is a controversial subject. But I feel that these patients' symptoms, which are often severe, have been dismissed many times as complaints of malingerers or neurotics. In our clinic, we have found present an actually existing abnormal condition which usually responds well to orthoptic training.

FATIGUE OF ACCOMMODATING MUSCLES

The second problem we have been studying during the past year is also related to accommodation and convergence. You have no doubt heard many ophthalmologists state, "Convergence insufficiency does not cause symptoms." This statement is made frequently and with reason. Why is it that in a group of 20 persons, all of whom may have a near point of convergence of 75 to 100 mm., only two or three will complain of symptoms? The doctor may classify some of these people as neurotics because their symptoms are vague and varied but, nevertheless, cause great discomfort. There must be some other answer to this problem.

Unfortunately, orthoptists seldom examine normal, symptom-free patients. These have been examined by the ophthalmologist or, in most cases, they never even enter the doctor's office. Consequently, there is little opportunity for comparative studies. Last fall, however, we did have an opportunity to examine a group of 50 student nurses, an intelligent, unselected group of young adults who are engaged in a certain amount of "close work." The results of this survey were:

1. Thirty-three girls had a near point of convergence of 50 to 95 mm. and one half of these had symptoms of eye strain.
2. Thirteen girls had a near point of convergence of 100 mm. or more, and one third of these had symptoms of eye strain.
3. Four girls had a near point of convergence of 40 mm. or less.

These results would suggest that there was no relationship between their near point of convergence and their symptoms.

During the examination we also tested their powers of accommodation at twenty feet using minus four spheres and a Snellen chart. Fifty per cent easily read the 20/20 line. Sixty per cent of the remaining half, who obtained varying results between 20/40 and 20/200, had symptoms of ocular discomfort. This result suggests some relationship between weakness or fatigue of accommodating muscles and symptoms. As a consequence of this small survey, we began testing the accommodation of all patients who were referred to our clinic with symptoms of visual discomfort.

The majority of our patients in this group are between 20 and 35 years old and, as such, should be able to exert three to five diopters of accommodation. We therefore tested the near and distant *binocular* vision of all these patients with minus four spheres. Ideally the amount of sphere should be stepped up gradually, but we find that if we allow the patients a few moments to adjust and then ask them to start reading at the top of the Snellen chart and proceed slowly downward, they do very well.

A typical case is that of a young woman, 26 years old, who arrived at the clinic complaining vaguely that her "eyes were tired" after a day of work. She was a bookkeeper. On the prism and cover test she measured six diopters of exophoria for distance and near. Her near point of convergence was 110 mm. Accommodation was normal for near and remained normal with minus four spheres, that is, 20/15 binocularly. (This was usually found to be the case.) However, her distant binocular vision, which was 20/20, dropped drastically to 20/300 when tested with minus four spheres. Here was evidence of a weakness or fatigue of accommodating muscles.

No effort was made during treatment to induce her to exert her accommodation specifically but it was stimulated during convergence exercises. After four visits to the clinic and conscientious home exercises, her near point of convergence had improved to 65 mm. We then again checked her distant binocular vision with minus four spheres and her visual acuity was 20/25. This type of patient is very common to our clinic, responds rapidly to treatment and the relief of symptoms is marked.

Another instance of the fatigue of accommodating muscles was that of an 11-year-old school girl who was having "reading problems." The only definite subjective symptom we could obtain was that she disliked reading because it hurt her eyes. Her near point of convergence was 100 mm. and binocular vision for distance was only 20/30. With minus four spheres, she could see "nothing" and displayed a definite aversion to accommodation.

After three treatments at the clinic, and with home exercises, her convergence was unlimited and her visual acuity was 20/25 with minus four spheres, an improvement in binocular vision and in accommodation. Along with her convergence training at home this patient used an Ortho-Fuser and was asked to "keep the pictures clear" in all exercises. She returned to us two months later and was found to have maintained her improvement perfectly. The subjective symptoms were no longer present.

In both these cases, and many others, the weakness of convergence muscles was present but not excessive, that is, hardly sufficient to have caused the severe symptoms that were experienced, but the loss of accommodation was marked. Therefore, we feel that it is very probable that in these types of cases, the fatigue of accommodating muscles is the true culprit, not the slight insufficiency of convergence.

ABNORMAL RETINAL CORRESPONDENCE

Our third problem concerns "optical crutches." If a patient appears to be unable to gain perfect normal function without a crutch, why not teach him to use that crutch as efficiently as possible? This was our thought when we decided to try to teach a selected few of our patients greater "fusional amplitudes" using their already firmly established abnormal retinal correspondence pattern.

We treat patients with abnormal retinal correspondence preoperatively, with success in some cases, but with disappointing failure in many. Even so, we still feel that a strong effort should be made to try to establish normal correspondence before operation. But when we fail, and operation also has failed to dislodge the pattern, what then?

Some of these patients return to the clinic postoperatively with their angle of deviation greatly reduced. Cosmetic results are good, but func-

tional results are not. For instance, patients may have abnormal fusion for near, but constant diplopia for distance. At this point we should cease our effort to establish normal binocular vision, accept the patient the way he is, and try to make him more comfortable and efficient with the visual pattern that he has and apparently is going to keep. We have treated these patients by trying to change their subjective angles. We try to improve their amplitudes of convergence and divergence and develop a type of binocular single vision for all distance, regardless of the fact that it is abnormal. Of course, this treatment is only feasible when the patient has equal, or nearly equal, visual acuity in both eyes. Unfortunately, I cannot say that we have had an unqualified success in this experiment.

Five patients of the ten showed no improvement whatsoever. For example, one man, on first examination, had equal vision, four abnormal Worth four dot lights for near, and constant homonymous diplopia for distance, and measured fifteen diopters esotropia. He had a small unharmonious subjective abnormal angle. Through surgical treatment and postoperative orthoptic exercises, we tried to change his subjective angle, but he continued to elicit homonymous diplopia for distance, although he now had only four to six diopters of esotropia. The other four failures were similar to this, that is, they had diplopia either constantly or just for distance, but all our efforts to increase their abnormal binocular range were without success.

Five patients appeared to respond, although response was only partial in some cases. One girl on first examination showed fifteen diopters of alternating esotropia, with an unharmonious angle of anomaly. We tried to develop normal retinal correspondence during seven treatments, with no success. However, her eye had been constantly occluded during treatment and the angle now appeared to be considerably less, six to eight diopters. We then abandoned stimulation of the normal reflexes and attempted to change the subjective angle, trying to encourage anomalous fusional amplitudes. After six more visits to the clinic her subjective amplitudes appeared good and she now claimed four Worth four dot lights at distance and near; the cosmetic result was very good, although the cover test revealed a shift of the left eye. We checked her nine months later and she still had six diopters of esotropia and claimed four Worth four dot lights. This, as far as we can see, appears to be very successful.

A second case is also encouraging. Preoperatively, this girl had 25 diopters of left esotropia with a visual acuity of 20/100 in the left eye. She had a subjective crossing point on the troposcope at zero, and after ten treatments we had gained only intermittent simultaneous perception and fusion with stimulation, although the vision in the amblyopic eye had improved to 20/30. She then had surgical treatment and returned with a residual angle of six to ten diopters. She now had alternate suppression to the Worth four dot test. The subjective angle was still zero, meaning that she had a large reduction in her angle of anomaly. Preoperatively, the angle measured 25 diopters, and postoperatively, eight diopters, as subjectively the images still crossed at zero. We gave five treatments still stimulating the normal retinal points without effect, so we then altered our treatment and treated her subjectively only. She responded by demon-

strating steady fusion with good amplitudes after four visits and now claimed four Worth four dots for distance and near. Her vision in the nonfixating eye remained at 20/30. This, too, is a case that seemed to show definite improvement.

Two other young patients also showed similar responses to this type of treatment, but I will not go into further detail. However, I would like to describe the case of a 34 year old man who apparently has had a small esotropia since childhood, with abnormal retinal correspondence. He sees four Worth four dots distance and near and has eight diopters of right esotropia. This patient suffers from symptoms of eye strain and therefore was referred to our clinic for treatment. He has returned during the past four years for four short series of treatments during which we treat him by trying to change his subjective angle and increase his fusional amplitudes of divergence and convergence. He has no stereopsis.

At the end of six treatments at the clinic, with home treatment as well, his symptoms are relieved but return again within a year. We have tried to persuade him to do continual home exercise in order to prevent the return of these symptoms but have had no success; we will no doubt see him again in another few months.

We have a patient right now with symptoms similar to those of the above adult patient. She is an example of the type that we consider a possible candidate for this type of treatment. The girl is 13 years old, has six diopters of esotropia with four diopters of left hypertropia, and claims four Worth four dot lights distance and near. She also has a visual acuity of 20/40 in her amblyopic eye. Cosmetically, she has no problem, but she is having headaches and other symptoms. We feel that occlusion for the amblyopia, which is not great, is not advisable at this age, and development of normal correspondence is highly unlikely. Therefore, treatment at the subjective angle in an effort to erase her symptoms only, is recommended.

Progress was made in five out of ten patients we treated, but of course only time will tell whether this progress is maintained. Ten is a very small number from which to draw any conclusions, but we are sufficiently encouraged to continue. But even so, in another year, at the present rate, we still will have treated only twenty or twenty-five cases, which is certainly not enough to indicate definitely whether this idea should be developed or discarded. Therefore, we are asking your help. If you feel that this type of treatment of selected cases of abnormal retinal correspondence has possible merit, will you try it out in your own clinics during the next year? Perhaps by next October we will have a sufficient volume from which to make a decision.

These variations of old problems, treatment of victims of head injuries and whip-lash injuries, relief of symptoms by increasing the power of accommodation, and the subjective treatment of intractable cases of abnormal retinal correspondence, are examples of what you may consider unusual orthoptic problems. However, we do not feel that this is true.

We began treatment of our first case of whip-lash injury eight months ago and since then have seen thirty-two of this type. One year ago when in desperation we treated the first child with abnormal correspondence at his subjective angle, we had no idea that possible candidates for this type

of treatment would appear as frequently as they have, which has been about one a month. The same can be said of our cases of accommodative muscle fatigue. So these are not unusual problems; we have just taken a new approach to them and feel that perhaps a new approach to many of our old orthoptic concepts would bring out some new possibilities and even some new solutions.

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OBSTACLES TO FUSION

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The phenomenon of fusion is as basic to orthoptics as electricity is to modern mechanized living. Yet we are able to make use of both fusion and electricity without having ultimate knowledge of either.

We can define fusion as the integration of light sensations from the retina of each eye by the brain into a single visual perception. While there is some evidence indicating that single binocular vision may involve factors other than fusion, such as retinal rivalry, inhibition and dominance, in this presentation they will be considered as one.

FUSION DEVELOPMENT

The conjugate fusion reflex becomes established five to six weeks after birth so that both eyes will follow a light for a few seconds. At three months the eyes will follow a small object and the change from reflex to conscious fixation becomes apparent. At four months, hand and eye become coordinated for quick horizontal movements. At six months conjugate movements become accurate. By the end of the first year corrective fusion reflexes are firmly established.

At five years of age, reflexes temporarily conditioned acquire the stability of a nonconditioned reflex and, barring any catastrophe, will continue to be so maintained throughout life. As each reflex passes from the conditioned to the unconditioned response, it is understandably strengthened by its satisfaction and encouragement in the form of clearer vision. If this reward of more vivid perception is lacking, the various fusion reflexes may at best become only poorly developed.

OBSTACLES TO FUSION

Obstacles to fusion are of two main types: (1) failure in the development of fixation reflexes, and (2) failure in function or structure causing the interruption of reflexes already formed.

Failure in Development

The first type is actually a congenital form and may be classified into three subtypes: (a) lack of development of fixation for each eye results in nystagmus; (b) failure of convergence results in periodic squint (here there may be fusion for distance and not for near); (c) failure of the conjugate fixation reflex results in the typical concomitant squint. Structural defects are an important cause of failure in individual ocular movements. This category includes cases of congenital palsies of the third, fourth or sixth nerve, as well as those conditions where the ocular muscles show no true elasticity or are restricted by aberrant fascial bands.

Failure in Function

The second type of obstacle, failure in function or structure causing interruption of established reflexes, may actually be considered the acquired form. In the acquired dissociation, noncomitant strabismus re-

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sults from a disruption of the peripheral oculomotor mechanism. When there is a disruption of the central oculomotor mechanism, we have the usual conjugate deviation.

We may further analyze the obstacles to function of the fixation reflex by classing them as: (a) optical, (b) sensory, (c) motor, and (d) psychological.

An obstacle is considered optical when the images formed on each macula are too unlike in clarity, size, and brilliance to be blended into one. Extrinsic factors may be responsible. Here may be included the disruption of binocularity by prolonged occlusion or uniocular atropinization in the therapy of ocular inflammation, the dissociation produced in young children by improper corrective lenses and the occupational hazards of monocular fixation seen in microscopists or loupe-wearing jewelers. Truly ocular obstacles such as high refractive errors, anisometropia, aniseikonia, corneal and lenticular opacities are all capable of preventing fusion.

Sensory obstacles to fusion may cause nystagmus when there is failure in development or congenital disease of the macula or of the optic pathways. However, if fixation has already been established, comitant deviations will result instead. Even blindness in one eye, if occurring in adult life, may not cause significant change in the relative position of the two eyes and in their motility.

Motor obstacles may be static, kinetic or neurogenic in nature. Static or anatomic defects include anomalies in shape, angulation or position of the orbits as well as of the globes themselves. Abnormal insertions and alterations in the quality of muscle elasticity are additional anatomic factors. The importance of this group becomes apparent when we observe how often one orbit is found lower than the other, or when we discover at operation aberrant bands and inelastic ligamentous muscles. Kinetic obstacles involving the accommodation-convergence ratio as found in uncorrected hypermetropia and myopia are well known. Among neurogenic obstacles may be listed those resulting from disease or injury at any level. When the lesion affects peripheral neurons noncomitant strabismus occurs; when supranuclear in location a gaze paralysis results.

Finally, psychological obstacles to binocular fusion reflexes may be considered. Mentally defective persons or hypersentitive or overactive individuals may display ocular muscle incoordination. Left handedness, stammering, mirror writing and assorted facial tics may be related reflex disturbances. When higher brain centers are not mature in their development, sudden changes act as a shock upsetting the delicate balance which must exist between the two cerebral hemispheres. It must be admitted that many children with strabismus are constitutionally inferior and labile in nature. In these cases, hemispheric balance enabling compliance with Sherrington's law of reciprocal innervation or Hering's law of motor correspondence is readily interrupted. Slight anatomic or pathologic abnormalties may often be sufficient to create the interference.

TREATMENT

In the treatment of fusional abnormalities and strabismus, it is obvious that we must seek out the specific factor involved. Optical factors such as ametropia, anisometropia, and aniseikonia may generally be eliminated by suitable spectacles or contact lenses. Opacities of the media may often be eliminated by surgical treatment.

Orthoptic training plays its greatest role in the elimination of sensory, sometimes motor, and invariably psychological obstacles to fusion.

Rønne developed experimental evidence for his assumptions that a point-to-point relationship exists between the retinal functional units and their respective end stations (or ganglion cells) in the occipital cortex of the brain; that pairs of ganglion cells representing the end stations of the visual pathway proper of the right and left eye are physiologically and innately coupled; that potential couplings exist not only between corresponding, but also between disparate cortical ganglion cells, setting up a surface of reference or horizon; that the potential couplings can be increased by training, thus demonstrating that facilitation of the cortical integrations can be achieved by repetition. He claims that, "It is on this fact that all procedures known as orthoptic treatment rest."

If there is true disease or pathologic change in the macula or visual pathway, the prospects for treatment are, of course, poor. The treatment of amblyopia, creation of diplopia and, finally, single binocular vision is a well-known sequence to orthoptists.

We must constantly be aware of the need to eliminate the psychological obstacles to fusion. Javal was one of the first to recognize the functional element as well as the operational element in strabismus. The newer tranquilizing drugs may help to make this task of eliminating the functional element somewhat easier.

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EFFICIENT READING

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THE average professional individual feels obligated not only to read those publications which keep him abreast of current public events and those which provide him with the necessary relaxation from the stress of his work, but also to read those which necessarily keep him informed within his profession. The problem of reading thoroughly every issue of each newspaper, magazine, and professional journal one receives—in addition to the occasional book one might find the courage to attack—becomes extremely acute. There just isn't time. There is too much to read.

This is not the only aspect of the reading enigma in which many of us find ourselves. Our frustrations are compounded by the awareness that the task of sitting down and reading a book or professional journal, for example, is drawn out and tedious. It would be interesting to know how many persons allow issue after issue of their professional journals to accumulate on their shelves with very little in them having been read.

But there is little wonder that this occurs when we observe the manner in which many of us read. Our reading habits seem to be such that reading actually becomes distasteful. We spend hours on a single chapter. It takes weeks to read a book. A single professional article takes most of an evening to understand. We haven't finished one issue of *Time* before the next one has arrived.

And it not only takes a long time to read, but during the time we are reading and after we have finished, we are not sure that we have understood or will long remember what we have read.

The reasons underlying this problem are many and complex, but there are three observable reading habits which appear to be contributory and which can be discussed briefly. Further, something can be done to correct these improper habits. As long ago as 1949, Professor James I. Brown of the Department of Rhetoric of the University of Minnesota instituted a course in "Efficient Reading" which has since grown and is currently being offered on three levels: to incoming freshmen, to upperclassmen and graduate students, and to adults in evening extension classes.

DETRIMENTAL READING HABITS

The three detrimental reading habits are: subvocalization, word-for-word reading, and regressing (going back over material just read). All three habits are intricately connected and frequently appear together. They enhance slow reading which, in turn, creates problems of comprehension for the reader.

The subvocalizer or person who inaudibly speaks what he reads, inhibits his speed because he can read no faster than he can talk, and few persons speak faster than two hundred words per minute.

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The word-for-word reader, who may also be a subvocalizer, creates an additional problem for himself. Although words have meaning, *ideas* usually consist of *groups of words* or phrases. Thus, the person who reads word-for-word has to "put" the *meanings* together to understand the thought. The person who reads in phrases or thought-groups, then, has the following triple advantage: (1) he does not have to "construct" the meaning of what he reads in a piecemeal fashion, for he perceives what he reads as he reads it; (2) he increases his speed by the thought-group method because he must "take in" more words in any one moment than in the word-for-word method; (3) he is naturally immune to subvocalization because he is reading too rapidly.

The third disruptive habit to efficient reading is *regression*. The reader who feels insecure in his understanding of what he reads will frequently re-read what he has just read to "understand" it or to remember it better. This may be caused by one or both of the first two bad habits mentioned, and it compounds the reading problem by creating its own difficulties.

The person who regresses not only loses time by doubling or tripling the time he spends on the portion over which he regresses, but he also increases the difficulty of understanding what he reads by stopping or going back, thus breaking the continuity of thought. The person who does not regress, does not subvocalize, and reads thought-groups, reads more rapidly and understands more of what he reads.

It is the purpose of the "Efficient Reading" course offered by the Department of Rhetoric at the University of Minnesota to accomplish these ends, that is, to increase both the reader's rate of reading and the comprehension of what he reads.

The remainder of this discussion will be a brief account of how this is attempted.

METHODS OF CORRECTION

"The Five-Way Approach to Better Reading" used in the afore-mentioned course involves the following tools:

(1) Harvard and Purdue Reading Films

(2) Tachistoscopic Training

(3) Master Word Vocabulary Series

(4) Timed readings

(5) Paced readings

The Harvard and Purdue Reading Films project continuous text material (book chapters and magazine articles) on the screen so that only a portion of a line of print is exposed at any one time. The left-to-right exposures start with four each line and by the end of the course there are two each line. This requires the student to increase his eye-span as time progresses and it forces him to read an increasingly greater number of words per fixation. The fixations are momentary (and increase in speed with time). They proceed across the line of print and down the "page" from line to line. When the last line of print has been shown, the exposures begin at the top line of the next "page". This duplicates, in a real way, the general procedure of book reading. Students are tested on the contents of each film.

The films generally eliminate both subvocalization and word-for-word reading because too much is exposed and must be understood at any one moment for these habits to be utilized. Regressions are impossible because once an exposure is gone that portion of the line of print can no longer be seen.

This tool tends to increase both speed and comprehension by establishing phrase-reading habits, speed habits, rhythmic left-to-right eye movement, and elimination of disruptive regressions.

The tachistoscope is a specially designed slide projector which can project selected items on a screen at speeds from 0.1 to 0.01 of a second. Class exercises using numbers, words, phrases, and sentences are flashed on the screen at 0.1 of a second early in the course progressing to 0.01 of a second near the end. Students are tested on the projected materials.

The results are similar to those of the film in that the flashes are too rapid for subvocalization, word-for-word reading, or regression. The fundamental purpose of this device is to increase perceptual speed and accuracy.

Under the assumption that a larger vocabulary makes for fewer comprehension problems in reading, increasing vocabulary is stressed. This is done through the Master Word Series: fourteen English words containing over thirty Latin and Greek prefix and root elements. The understanding of these word elements, it is assumed, provides the key to thousands of English words in which they are found. Each Master Word is accompanied by a slide of twenty related words and phrases which are flashed on the screen with the tachistoscope. Thus, the purposes of regular tachistoscopic training are coupled with vocabulary building in the use of this device.

The fourth means of training which is utilized is the timed reading. Each student is timed in his reading of selections from text materials and is tested for comprehension. Thus, a constant check is kept on the individual's reading rate and his apparent level of comprehension.

The timed reading is flexible insofar as the reading rate can be varied to suit different purposes. The class can be instructed to read one selection for "speed," another for "comprehension," and another for "normal" purposes. The student, as a consequence, is taught to become flexible in reading rate—that is, to vary the rate according to the intended purpose of the reader and the nature of the material to be read.

Finally, the paced reading attempts to do with actual text material what the films and tachistoscope do with projected materials. In this type of exercise, the class is required to read at a faster-than-average rate which is fairly well controlled. The rates are fixed at 500, 750 and 1,000 words each minute—the increases established as the course progresses. The instructor maintains control over the rate by designating the moment at which students must proceed from one column of print in an article or from one page to the next. (The pacing times have been previously established.) Each student must begin the next column or next page whether or not he has reached that point. (Some students are able to keep ahead of the instructor, which is encouraged.) After a number of trials, most people are able to "sense" the currently established pacing rate and thus keep up with the instructor.

Since the pacing rate is kept in advance of the normal reading rates in the class, the forced faster reading demands the utilization of the reading skills stressed in the films, tachistoscope and Master Word Series.

CONCLUSION

The person interested in becoming a better reader is able to achieve most of what he desires by eliminating the bad habits of subvocalization, word-

for-word reading and regressing. The approach used at the Unversity of Minnesota's Department of Rhetoric has been summarized.

Efficient reading is not truly measured in larger and better scores in reading speed and in comprehension tests. Rather, it is measured by cutting in half the time it takes to read one's professional materials or by sitting down and being able to read a book in an evening—and to understand and remember it. In other words, reading becomes the source of personal growth and enjoyment it is meant to be.

INCREASING THE AWARENESS OF DIPLOPIA IN STRABISMIC PATIENTS

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SOME strabismic patients are more aware of diplopia than others. They can be classified into four groups:

a. Some patients see two images of whatever object they look at (unless it is too big), and they cannot get rid of either image.

b. Some patients are able to be aware of diplopia or not, as they choose.

c. Some patients are aware of diplopia only under special conditions, as when viewing a small white light in a dim room with a red glass before one eye.

d. Some patients are not aware of diplopia even under those conditions.

The purpose of this paper is to show that strabismic patients become more aware of diplopia when they practice repeated alternation of fixation while temporarily aware of diplopia. The experiment was conducted as follows:

1. With the aid of a special apparatus, 59 strabismic patients were made temporarily aware of diplopia.

2. Each of these patients was taught to be able to fixate with each eye in turn, so that he could then alternate back and forth repeatedly between right-eye fixation and left-eye fixation.

3. Every patient practiced such alternation, while aware of diplopia, as a daily home exercise.

4. Every patient was examined periodically for awareness of diplopia according to the classification described.

In the home exercises and in the tests for awareness of diplopia, the patient could at any time reach for, or walk toward, the object that he was asked to look at. By doing so, he could make a nonvisual evaluation of its position.

SELECTION OF PATIENTS

Each of the 59 patients had been referred by a practicing ophthalmologist to the orthoptic department of the Kresge Eye Institute. They were not selected on the basis of any diagnostic procedures other than those employed by the referring physicians. These patients are described in table I.

APPARATUS

The apparatus (Fig. 1) consisted of (1) a viewer which transmitted only vertically polarized light to one eye and only horizontally polarized light to the other eye, and (2) a light-box six inches high, six inches wide, and twelve inches long. The front of the light-box was a ball-and-square cut-

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A. D. Ruedemann, M.D., Director of the Kresge Eye Institute, and Miss Arlene Stearns, head of the Orthoptic Department of that Institute, made patients and facilities available for this investigation. Miss Stearns, Miss Beverly Lasher, and Miss Sally Ferney, certified orthoptists, participated in the research, and the study would not have been possible without their generous cooperation and competent assistance.

Table I

Summary of Relevant Medical History for Each of the 59 Strabismic Patients Used in This Experiment.

PT.	SEX	AGE YRS.-MOS.	AGE AT ONSET	PREVIOUS ORTHOPTIC TRAINING	VISUAL ACUITY (CORRECTED)		SCREEN AND PRISM	
					OD	OS	6 m	33 cm
H.Bu.	M	44-0	7-0	None	20/20	20/20	X^T33 LH^T7	X^T45 LH^T7
L. Ch.	M	8-7	Birth	None	10/200	20/30	Nystagmus OD	X^T9 RH^T11
D. C.	M	27-9	6-0	None	20/20	20/100	X^T45	X^T45
W. D.	M	26-6	Not known	None	20/15	20/20	E^T35 LH^T4	E^T18 LH^T1
E. E.	M	10-6	Birth	2 yrs.	20/20	20/20	E^T16 RH^T6 LH^T9	E^T5 RH^T6 LH^T9
J. H.	M	6-8	4-6	3 visits	20/20	20/20	E^T14	E^T28
R. Ja.	M	9-9	Not known	15 mos.	20/40	20/30	E^T7 LH^T2	LH^T3 X^T-E^T7
R. Ka.	F	5-6	3-0	8 mos.	20/40	20/30	E^T20 LH^T2	E^T16 LH^T3
J. Lo.	F	4-0	1-1	8 mos.	20/20	20/20	E^T10 RH^T15	E^T23 RH^T12
M. Lu.	F	10-2	Not known	2 yrs.	20/50	20/20	E^T8 RH^T2	E^T12 RH^T5
R. Ma.	M	6-7	Birth	None	20/300	20/30	X^T RH^T	X^T21 RH^T17
J. Ma.	M	10-9	10-0	5 mos.	20/50	20/30	E^T6-14 LH^T2	E^T8-12 LH^T1
J. Re.	M	7-1	1-0	None	20/30	20/30	E^T8	E^T16 RH^T2
L. Ru.	M	8-7	1-0	None	20/15	20/20	E^T35 LH^T6 RH^T4	E^T33 LH^T6 RH^T4
J. W.	M	13-11	Birth	None	fingers 5 feet	20/20	X^T30	X^T30
M. W.	M	5-9	2-0	None	20/30	20/200	E^T50	E^T50
L. Z.	F	6-10	2-0	None	10/200	20/15		E^T25
T. A.	M	10-3	Birth	None	20/30	20/50	E^T5-12 RH^T8 LH^T12	E 5 RH^T7 LH^T9
B. B.	M	5-10	1-0	1½ yrs.	20/20	20/20	E^T12	E^T7
C. Bi.	F	7-11	1-6	4 yrs.	20/20	20/20	E^T3	E^T2
M. Bo.	F	9-8	1-0	2 yrs.	20/30	20/30	E^T12	E^T10
C. Br.	M	10-4	8-0	None	20/20	20/100	E^T10	E^T6
D.B.	M	10-10	6-0	4 yrs.	20/15	20/50	E^T8	E^T14
N. Br.	F	11-6	2-0	6 yrs.	20/30	20/20	X^T10 LH^T	X^T18 LH^T
M. Bu.	M	13-2	0-9	None	20/20	20/30	E^T28 LH^T3	E^T28 LH^T3
C. Ca.	F	10-2	Birth	5 yrs.	20/20	20/40	X^T1 LH^T9	X^T-E^T
L. Cl.	F	6-7	4-6	1 mo.	20/30	20/20	E^T14 RH^T1	E^T18 RH^T1
M. C.	F	7-0	3-0	None	20/30	20/30	E^T23 RH^T	E^T28-33 RH^T2
C. Cu.	F	6-1	2-0	6 mos.	20/20	20/20	E^T10 RH^T2	E^T23 RH^T3

PT.	SEX	AGE YRS.-MOS.	AGE AT ONSET	PREVIOUS ORTHOPTIC TRAINING	VISUAL ACUITY (CORRECTED) OD	OS	SCREEN AND PRISM 6 m	33 cm
R. Ku.	M	9-8	1-0	5 yrs.	20/30	20/30	X^T 6 LH^T 7	E^T 7 LH^T 8
P. M.	M	6-10	Birth	1½ yrs.	20/20	20/30	X^T 14 LH^T 2	X^T 2 RH^T 7
R. Mi.	M	8-6	1-6	None	20/30	20/40	E^T 12 LH^T 2	E^T 14 LH^T 2
D. O.	M	6-10	2-0	2 yrs.	20/40	20/30	E^T 4	E^T 10 X8
B. P.	F	13-1	1-0	None	20/20	20/20	X^T 28	X^T 33
T. P.	M	6-0	4-0	4 mos.	20/30	20/30	E^T 7	E^T 12
S. P.	F	19-10	3-0	None	20/200	20/20	E^T 22 RH^T 10	E^T 18 RH^T 10
C. P.	F	12-6	Birth	6 mos.	20/30	20/50	X 6-25 RH^T 5 LH^T 5	X(T) 40
J. Ra.	M	15-0	4-0	None	20/20	20/30	E^T 6	E^T 7
P. T.	M	7-0	1-0	5 mos.	20/20	20/100	E^T 12-23 RH^T 4	E^T 10-20 RH^T 3
R. W.	M	9-0	1-0	1½ yrs.	20/20	20/20	E^T 16	E^T 8
D. A.	M	10-4	3-10	4¼ yrs.	20/30	20/30	E^T 3 LH^T 1	E^T 3 X^T 2
J. B.	M	7-7	2-0	3 yrs.	20/40	20/30	E^T 16	E^T 3
N. Ba.	M	9-11	2-0	6 yrs.	20/20	20/15	E^T 3	E^T 8
G. B.	M	17-1	3-0	None	20/40	20/20	X^T 6 RH^T 2	X^T 14 RH^T 1
R. C.	M	8-1	2-6	2 yrs.	20/100	20/50	X^T 5 LH^T 8	E^T 10 LH^T 5
D. D.	M	9-11	1-6	3½ yrs.	20/15	20/15	E 16	E(T) 10
T. F.	F	5-11	2-6	None	20/30	20/30	E^T 23	E^T 4 E 20
D. G.	M	11-7	2-0	4 yrs.	20/30	20/20	E^T 2	X^T 2
D. H.	M	7-2	4-0	2 yrs.	20/30	20/30	E^T 6	E^T 18
P. H.	M	8-10	2-0	1½ yrs.	20/30	20/30	E^T 5	E^T 8
D. N.	F	7-6	1-0	3 yrs.	20/40	20/20	E^T 9 LH^T 2	E^T 20 LH^T 6
T. O.	M	9-2	Birth	1½ yrs.	20/20	20/20	E 1-2 RH^T 3	E^T 14 LH^T 14
L. R.	F	10-9	4-0	None	20/15	20/15	X 2 RH^T 1	E(T) 10 RH^T 3
P. R.	M	9-8	3-0	1 yr.	20/15	20/30	E^T 6	E^T 3
L. S.	F	7-1	1-0	2 yrs.	20/20	20/20	E^T 4	E(T) 4
B. S.	F	12-2	1-0	5½ yrs.	20/25	20/30	E^T 10 LH^T 2	X(T) 16
S. S.	M	7-11	2-6	3½ yrs.	20/40	20/40	E(T) 12	E(T) 12
J. U.	M	6-11	2-0	2 yrs.	20/25	20/25	E^T 18	E^T 10
E. W.	M	14-7	0-6	4½ yrs.	20/30	20/20	E^T 7 RH^T 2	X^T 8 LH^T 2

All data taken at the start of experimental treatment.
"Age of Onset" is age at which the strabismus was noticed.
Visual acuity measured at six meters using Snellen test letters.
Visual acuity and screen-and-prism measurements were made while patient was wearing his usual correction.
Abbreviations: E^T esotropia, E(T) intermittent esotropia
X^T exotropia, X(T) intermittent exotropia

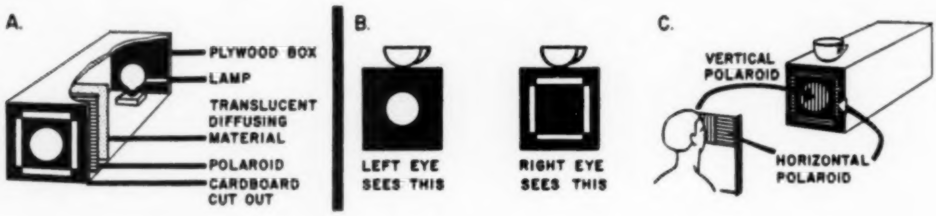

FIG. 1—Apparatus used for the elicitation of diplopia, for teaching alternation of fixation, and for the practice of alternation with diplopia. Under appropriate conditions of viewing every one of 59 patients was able to see the ball out of the square and to see both of them at the same time. The procedure for transferring "ball-and-square" diplopia to diplopia for an object is illustrated in B and C. Units of this type were made available to many patients for use in home exercises.

out which was illuminated from behind. The arrangement of Polaroid behind the cut-out was such that, in a dark room, only the ball was visible to one eye and only the square was visible to the other eye. The viewer was designed to make it easy for the examiner to observe the patient's eyes.

If a strabismic patient sees the ball out of the square (Fig. 1B) he has diplopia according to the usual definitions. Whether or not this is true diplopia is an academic issue. The point is that once a patient has ball-and-square diplopia, he can ordinarily be made aware of diplopia for objects.

In order to transfer ball-and-square diplopia to diplopia for an object, the object (a coffee cup, for example) is placed on top of the light-box (Fig. 1 B, C). The patient is then instructed to look for one coffee cup over the ball and one over the square.

Viewers and light-boxes similar to those shown in figure 1 were made available to many patients for use in home exercises.

PROCEDURE

Teaching Awareness of Diplopia

When first examined, 17 of the 59 patients were not aware of diplopia when viewing a small white light in a dim room with a red glass before one eye. Many of these patients were able to achieve ball-and-square diplopia after prolonged viewing (maximum one-half hour) in a dark room with a red glass in front of one eye. For the remainder, it was necessary to direct a glare source (flashlight) into the fixing eye, and to occlude and disocclude the fixating eye several times in rapid succession. With the aid of these techniques, all 17 patients became aware of diplopia for the ball and square.

Teaching Fixation with Each Eye in Turn

Patients who could not readily alternate fixation were taught to do so while viewing the ball and square in a dark room, with the ball seen by the fixating eye. With the fixating eye occluded, the patient was asked to look at the square and to make sure that it was straight ahead. If the patient said that the square was not straight ahead, he was instructed to walk the length of the room, still looking through the viewer and with one eye still occluded, and to touch the light-box. This was repeated until the square appeared to the patient to be straight ahead.

The patient then practiced keeping the square straight ahead while the other eye was momentarily uncovered

for longer and longer periods. Then with a red glass in front of the eye which saw the ball, and with the aid of intermittent occlusion of that eye, each patient was taught to switch voluntarily from "ball straight ahead" to "square straight ahead." In this way, every patient was taught to alternate back and forth repeatedly between right-eye fixation and left-eye fixation, at the rate of about one alternation per second, while aware of diplopia.

turn when doing this exercise, the applied cover test was employed. This test was carried out first when the left eye was fixating (right eye was covered), and then when the right eye was fixating (left eye was covered). The patient was considered to be performing the exercise correctly only when no movement of the fixating eye could be observed on application of the cover.

It was necessary to illuminate the fixating eye from the side in order

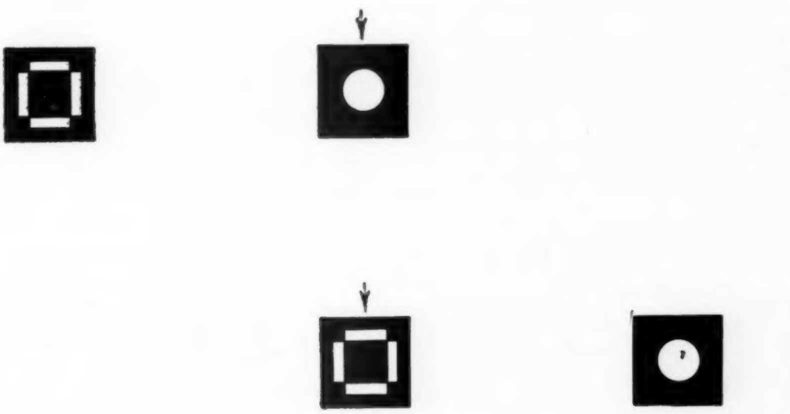

FIG. 2—Ball and square as seen by a patient with esotropia who is aware of diplopia when using the apparatus shown in Figure 1. The appearances associated with both right-eye fixation and left-eye fixation are shown. Arrows indicate the straight-ahead position. The figure illustrates the change in position of images which accompanies alternation of fixation with awareness of diplopia. Only one patient out of 59 failed to perceive this change in position as an apparent movement of the two images.

Figure 2 illustrates what a strabismic patient with homonymous diplopia sees when he performs the exercise in this manner. The upper part of figure 2 shows what the patient sees when his right eye (which sees the ball) is his fixating eye: the ball is straight ahead and the square is to the left. The lower part of figure 2 shows the appearance which accompanies left-eye fixation: the square is now straight ahead and the ball is to the right.

In order to be certain that the patient was fixating with each eye in

to watch for movement of that eye in a dark room. Some patients were not able to maintain fixation with the usually strabismic eye in the presence of such illumination. In these cases, it was necessary to rely on the patient's subjective reports, as described above and as illustrated in figure 2, in order to be certain that the exercise was being performed correctly.

For all patients, the appearance illustrated in figure 2 provided a means of ensuring the correct performance of home exercises. This technique, which greatly enhanced the effective-

ness of the home exercises, will now be described.

Alternation with Movement of Images

If the upper and lower portions of figure 2 are compared, it will be seen that the difference between them can be stated as follows: on alternating from right-eye fixation to the left-eye fixation, both images appear to shift to the right; and on alternating from left-eye fixation to right-eye fixation, both images appear to shift to the left.

In order to ensure correct performance of "alternation with diplopia" as a home exercise, an effort was made to teach every patient to appreciate this alternating change in position of the two images as an alternating *apparent movement* of images on each alternation of fixation. Only one patient (L.C1.) was unable to learn to perceive the change in position as movement, although another patient (D.A.) took six months to do so.

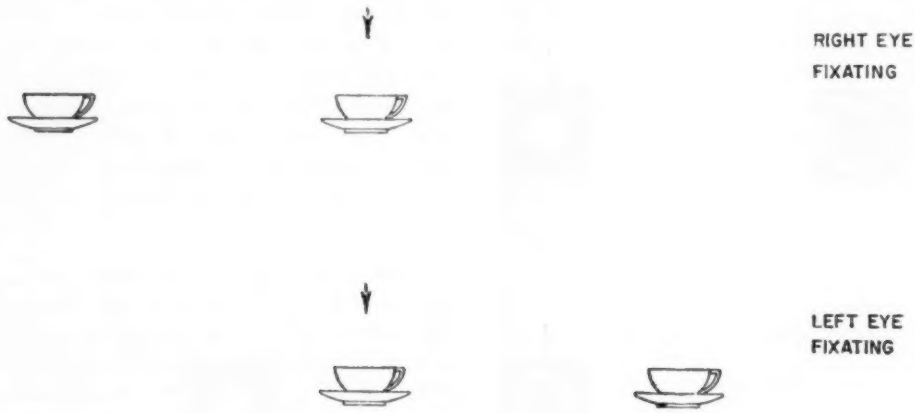

FIG. 3—The two images of a coffee cup as seen by a patient with esotropia with diplopia, with the right eye fixating and with the left eye fixating. Arrows indicate the straight-ahead position. The figure illustrates the change in position of images which accompanies alternation with diplopia. Only one patient in 59 failed to perceive this change in position as an apparent movement of the two images.

In figure 3 the same situation is shown, this time with a less artificial object (a coffee cup), so that the right-eye and left-eye images are similar.

Diagrams similar to those in figures 2 and 3 could also be drawn for crossed diplopia and vertical diplopias. In fact, any strabismic patient who repeatedly alternates fixation while aware of diplopia should perceive an apparent change in the positions of the two images. If his deviation is chiefly horizontal, he should see the two images "move" or "jump" or "shift" back and forth, from right to left and back again.

Once a patient had learned to perceive apparent movement with alternation, he was instructed extensively in the exact appearance which should accompany his performance of the exercise. The patient was taught that each image in turn should come to the straight-ahead position and that both images should move, on each alternation, as far as the distance between the two. This verbal instruction was supplemented by graphic and pictorial illustrations and by actually moving objects back and forth in front of the patient.

From the point of view of the patients in this experiment, the exercise

which they practiced at home did not involve alternation of fixation. It involved making the two images go back and forth so that first one is straight ahead and then the other one is straight ahead and so that they *move* every time.

Periodic Examination of Patients

Whenever possible, each patient was examined weekly. The main purposes of the examination were (1) to see if the patient was performing the exercise correctly and (2) to classify the patient with respect to awareness of diplopia.

To find out whether or not the patient was performing the exercise correctly, I relied on observation of his eye movements and also on the patient's description of how the two images appeared to move back and forth. When a patient was found to be performing the basic exercise incorrectly, a special remedial exercise was usually prescribed. It frequently happened that the best remedy was for the patient to do the exercise under more artificial conditions of viewing. For example, almost every patient found it easier to do the exercise correctly with the ball and square apparatus than with an ordinary object.

The procedure for classifying patients according to awareness of diplopia has been summarized earlier in this paper. That procedure will now be described in detail.

The patient was first examined in a bright room. His attention was directed to some object subtending not more than three degrees of visual angle—for example, a coffee cup—at a distance of six meters. There was only one coffee cup in sight. The patient was then asked, "Do you see one coffee cup or two?" He had a choice between two answers:

1. If he said "One," he had to be in group c or in group d. The room was then dimmed, a red glass was held in front of his right eye, and he was instructed to look at a small point of light six meters away. He was then asked, "Do you see one light or two?" If the patient saw two lights with the red glass in front of either the right eye or the left eye, he was placed in group c. If he did not see two lights, he was placed in group d.

2. If the patient said that he saw two coffee cups, he was asked, "Can you get rid of one?" or "Can you make one go away?" or "Can you make them one?" If he answered "Yes" to any one of these questions, he was placed in group b. If he answered "No" to all three questions, he was placed in group a.

It was necessary to be certain that the patient assigned to group b were not getting rid of one image by fusing. The applied cover test was used for this purpose. So far as could be determined, none of the 59 patients fused before being assigned to group a.

RESULTS

The main result of the experiment can be seen in table II. The number of patients in groups a and b increased during the experiment, and the number of patients in groups c and d decreased. The increase in the number of patients in group a is especially striking.

The awareness of diplopia increased measurably in 50 of the 59 patients (85 per cent). Since it is well known that strabismic patients do not ordinarily become more aware of diplopia in the absence of treatment, it may be inferred that this result is attributable entirely to the experimental procedures, and that al-

TABLE II
SUMMARY OF AWARENESS OF DIPLOPIA AT THE BEGINNING AND AT THE END OF THE EXPERIMENT

AWARENESS OF DIPLOPIA	NUMBER OF PATIENTS IN EACH CATEGORY	
	START OF EXPERIMENT	END OF EXPERIMENT
a. Has to see double	0	25
b. Can see double	19	22
c. Diplopia only for light in dark room with red glass	23	9
d. Little awareness of diplopia	17	3

ternation of fixation with temporary awareness of diplopia does in fact increase the awareness of diplopia in most strabismic patients.

No patient reported any visual discomfort or confusion associated with his increased awareness of diplopia.

DISCUSSION

Practical Implications

Two techniques have been described in this paper which may be of value in the treatment of strabismus. The first is the use of an apparatus such as that shown in figure 1 for the elicitation of awareness of diplopia. The general principle embodied in that apparatus is that a single object is caused to have a different shape to each eye. This principle has not, so far as I am aware, been previously employed for the elicitation of diplopia, although the practice of causing a single object to have a different color to each eye is well established. This apparatus has proved effective in eliciting a temporary awarness of diplopia in many strabismic patients who had been unable to become aware of diplopia under any other conditions.

Patient H. B., for example, was 44 years old when first examined, had equal visual acuity in his two eyes, and alternated fixation easily and frequently. He could not recall ever having been aware of diplopia. Nevertheless, it proved possible to make him temporarily aware of ball-and-square diplopia on first examination.

The second practical technique which has been described in this paper is that of having the patient practice repeated alternation of fixation while aware of diplopia. The results of the experiment clearly indicate that this technique will ordinarily cause strabismic patients to become progressively more aware of diplopia.

Hypothesis

When a strabismic patient is aware of diplopia, he ordinarily sees only one of the two images of an object (the fixing-eye image) in the place toward which he would reach if he wanted to touch the object. The strabismic-eye image of the same object is seen in some other place. Because he is aware that he will not touch the object if he reaches for the strabismic-eye image of it, the patient regards that image as illusory or un-

real. The reader may confirm these statements by examination of any strabismic patient who is aware of diplopia and who is able to give a reasonably accurate and reliable report of his visual experience.

These prominent features of visual perception in strabismus apparently have not previously been given their proper emphasis only because of the almost universal practice of employing a major amblyoscope or similar device in the examination of strabismic patients. Such devices should not be used in any examination which is conducted for the purpose of evaluating the foregoing statements, for those statements refer only to the perception of objects which the patient can touch or approach, and which the patient knows he can touch or approach.

The hypothesis for the present investigation may now be stated: strabismic patients who are not aware of diplopia differ from those who are aware of diplopia only in the degree to which they recognize the strabismic-eye image of an object as unreal. In other words, patients who are not aware of diplopia perceive the strabismic-eye image, but they reflexly perceive it as devoid of reality and so they are not aware of its presence. A simple analogy may serve to clarify this hypothesis.

Suppose that a patient were afflicted with an ocular disorder such that he saw a stone wall twelve inches in front of him. The stone wall is of course intangible, for the disorder is strictly ocular. The patient can see other objects through the wall and even in the same place as the wall. Suppose also that the patient had been afflicted with this disorder at an early age, during the developmental period when he was just learning that visual images represented objects which could be manipulated.

Without doubt the patient would regard the stone wall as unreal. He would do so for the same reason that the strabismic patient regards the strabismic-eye image as unreal: it is not there when he tries to reach for it. After a time, he would undoubtedly learn to act as if the wall did not exist, to ignore its presence. Is it not conceivable that, in spite of the persistence of the ocular disorder, the patient would become unaware of the presence of the stone wall?

That such a result is not only conceivable but inevitable is well demonstrated by the role of entoptic images[1] in normal visual perception. The retinal stimuli for these images are invariably present, but the images are intangible. They are visible only under special conditions of viewing and with appropriate instruction. When visible, they are perceived as "images," and the observer is aware that they cannot be approached or touched. Whether visible or not, they do not interfere appreciably with the perception of other visual stimuli.

The analogy is striking: every one of the foregoing statements applies to the strabismic-eye visual images of the strabismic patient as well as to the entoptic images of the normal individual.

Another way of clarifying the hypothesis is to use the words in which some strabismic patients describe their lack of awareness of diplopia. Some patients report that the strabismic-eye image of an object is so unreal that they are not certain whether they see it or not. Some say that it is so unreal that sometimes it's not even there. These statements express exactly the situation which, according to my hypothesis, is solely responsible for the lack of awareness of diplopia in the great majority of strabismic patients.

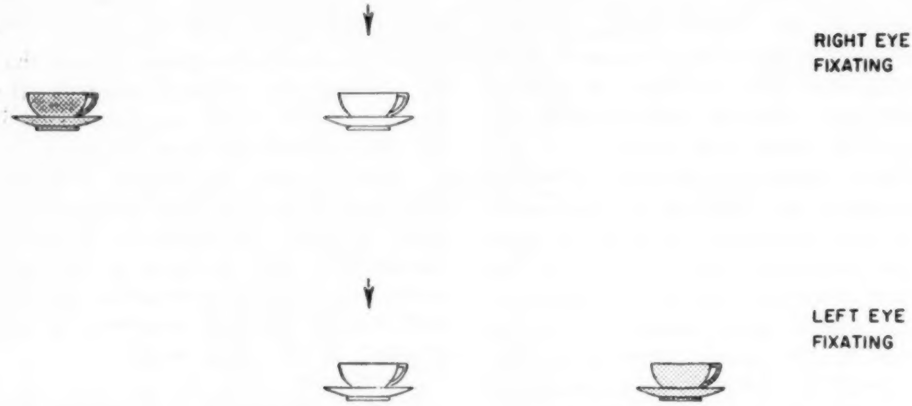

FIG. 4—The two images of an object (coffee cup) as seen by an esotropic patient with diplopia, with the right eye fixating and with the left eye fixating. The shading of one image in each portion of the figure represents the quality of unreality which the patient perceives in the strabismic-eye image.

Experimental Test of the Hypothesis

Figure 4 is similar to figure 3 except that the strabismic-eye image has been shaded. This shading is intended to represent the special quality of unreality which the squinting-eye image has for the strabismic patient. The figure shows that either visual image, taken alone, is alternately real and unreal when the patient alternates while aware of diplopia. The left-eye image, for example, is unreal on right-eye fixation and real on left-eye fixation.

Under ordinary circumstances, whether one is a strabismic patient or not, a single visual image is either real or unreal, and never changes from one to the other. This is a basic rule of the world around us: there is nothing that changes from object to image and back again. If anything appears to do so, we are aware that we have been deceived, and that something is wrong with our visual perception. When a magician makes a rabbit disappear and then reappear, we feel an impulse to rub our eyes, for we know that our eyes have deceived us.

But, as has been shown, this is exactly what happens when a patient alternates while he is aware of diplopia. Thus, in a sense, alternation with diplopia pits the real-unreal distinction against a more fundamental rule of visual perception. Continued practice of the exercise should therefore cause the real-unreal distinction to diminish. If that distinction is the means by which strabismic patients avoid diplopia, then the effect of the exercise should be to make patients more aware of diplopia.

Since 50 out of 59 patients became more aware of diplopia when they practiced the exercise, the hypothesis is supported by the results of this experiment.

The Use of Objects as Visual Stimuli

A fixing-eye visual image is real to a patient because he knows that if he reaches for that image he will touch the object which it represents. The strabismic-eye image of that object is unreal because the patient knows that he will not touch the object if he reaches for that image. It follows that the real-unreal distinction does not apply to all visual stimuli. In particular, it does not apply to visual stimuli which are presented

to the patient by means of an instrument such as the stereoscope or the major amblyoscope. The patient knows, for example, that if he attempts to touch the place where the amblyscope stimulus appears to be, he will not touch the object which that stimulus is supposed to represent.

All visual stimuli used in this experiment were such that their apparent positions were in complete agreement with their positions as determined by reaching and touching. The reason for this requirement will now be apparent. In order to study the real-unreal distinction in strabismus, it was necessary to use visual stimuli which the patient knew he could touch—that is, it was necessary to use objects as visual stimuli.

The Etiology of Strabismus

In order to describe the onset of a strabismic condition in terms of the present hypothesis, it is necessary to postulate a precipitating causative factor which is not directly related to the real-unreal distinction or to any other perceptual disorder. Either a temporary inability to maintain the precise motor coordination which is required for fusion or a temporary paresis of one or more extraocular muscles might account for the onset of a strabismic disorder.

The perceptual disorder which has been described in this paper may then be viewed as an adaptation to the temporarily deviated position of the eyes. The real-unreal distinction between fixating-eye and strabismic-eye images thus appears as an alternative to fusion: instead of seeing the two images as one by bringing them together, the strabismic patient sees them as one by perceiving one as an object and the other as an image. The latter interpretaion on the part of the patient follows naturally from his repeated attempts to touch or approach each of the two images.

As in the case of other physiologic and psychologic adaptations, the adaptation itself may then become responsible for the persistence of the disorder. In this instance, the adaptation is an extremely effective one, as demonstrated, for example, by the ability of many strabismic patients to be aware of diplopia without being inconvenienced by that awareness.

By this line of reasoning, it is possible to account for the cause of strabismus by postulating only that in some individuals the physiologic mechanisms which mediate the precise control of ocular movements mature more slowly than do the physiologic mechanisms which mediate the complex processes of visual perception. On that assumption, such individuals experience a developmental stage at which the demands of visual perception require that the two visual representations of any object be seen as one, but at which the capacity for bifoveal fixation of the object is not present. According to the present hypothesis, the real-unreal distinction is then adopted by such individuals as the perceptual mechanism underlying binocular coordination.

Later, when an ophthalmic examination is conducted, physiologic maturation may have advanced to the point where no physiologic deficiency can be observed. Only the perceptual anomaly remains, and it is sufficient to maintain the strabismic condition. Moreover, if the patient is then examined only on a major amblyoscope, it is logically impossible for the examiner to discover the presence of the basic perceptual disorder.

If the foregoing remarks are correct, then the real-unreal distinc-

tion which has been described here is responsible not merely for the lack of awareness of diplopia in strabismus but also for the persistence of the strabismic condition in the presence of awareness of diplopia. If this is true, then the visual exercise of alternation with diplopia is fundamental to all strabismic therapy. These and other deductions from the basic hypothesis are being evaluated in an experimental program now under way in this laboratory.

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HISTORY AND METHOD OF PRESCRIBING BIFOCALS FOR ACCOMMODATIVE ESOTROPIA

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In 1864 Cornelius Donders[3] announced the cause and effect in the relationship of accommodation and convergent strabismus associated with hypermetropia. Prior to 1896 Emile Javal[6] was the first to prescribe bifocals for the treatment of accommodative strabismus. He employed the Franklin type bifocal with reading additions of +3.00 diopter spheres. He also used half-eye glasses when no correction was required for distance.

In 1905 Linn Emerson[4] reported the use of bifocals (+3.00 diopter spherical pasters) in cases in which he used atropine. In 1914 Wendell Reber[8] reported 11 patients with esotropia for whom he prescribed invisible bifocals with +2.00 and +3.00 diopter reading additions. One-half per cent atropine was instilled in both eyes once daily and discontinued after two months.

Folk and Whelchel[5] prescribed bifocals for 35 patients with esotropia; they found little or no improvement in 13 patients. The esotropia was reduced but not corrected in 15 cases; in 7 cases the esotropia was corrected. Costenbader,[2] Tait,[9] Burian[1] and Parks[7] encourage the use of bifocals for the treatment of accommodative esotropia.

More ophthalmologists would have enjoyed greater success had the bifocals been properly fitted. There are two important factors which must be considered for bifocals to be properly fitted:

1. The top of the reading segment must come between the lower border and the center of the pupil.

2. The segments must be decentered inward according to the reading distance and the interpupillary distance.

The average interpupillary distance is 50 mm. for a child of 5 to 7 years of age. The reading distance is 25 cm. (10 inches) or a little less. Calculating this by the method described by Tait, each segment should be decentered inward 2 mm. so that the line of sight passes through the center of the reading segment while reading.

Figure 1 illustrates Tait's graphic method and formula for determining the proper centering of lenses for use at a near point.[9]

I have not found the width of the reading segment to be important. The kryptok invisible bifocal segment is 22 mm. in width and has proven to be most suitable. They are more readily accepted by the parents because the bifocals attract the minimum of comments from curious people.

Figures 2 and 3 demonstrate the position and appearance of the bifocals, and the average reading position of a 5 year old girl. The ink marks outline the reading segment so that the size and position of the reading segment can be seen in the photograph.

Aided in preparation by the Ophthalmological Foundation, Inc., New York, and Research Department of the New York Association for the Blind.

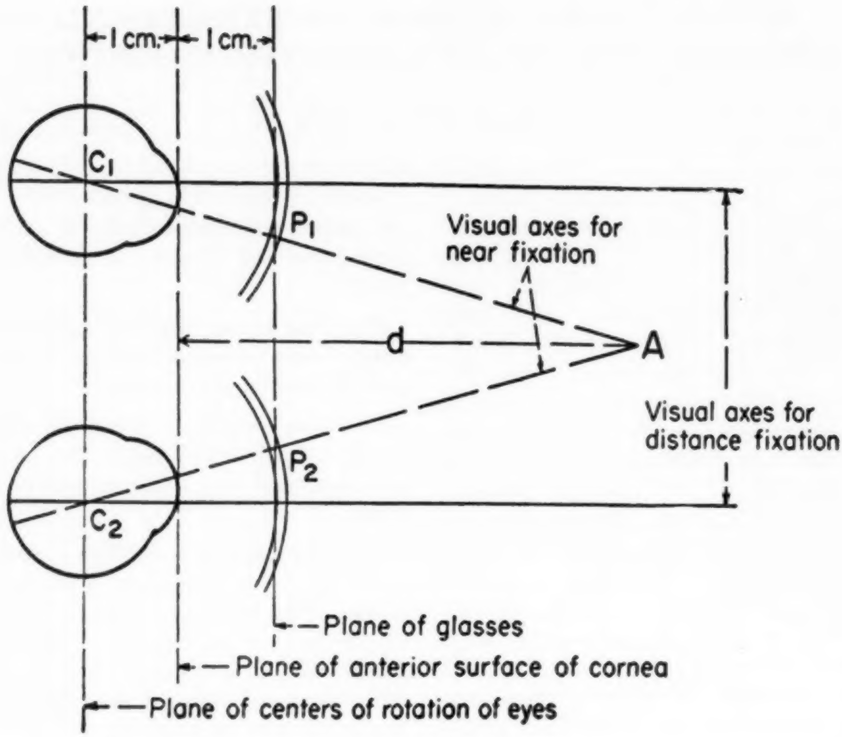

Figure 1

C_1C_2 = distance between centers of rotation (interpupillary distance)
P_1P_2 = distance between optical centers of lenses when fixing at near
d = distance of near point object from anterior corneal surface
A = fixation point at near

For example:

$$\frac{C_1C_2}{P_1P_2} = \frac{d + 1}{d - 1} \qquad C_1C_2 = 50 \text{ mm.} \quad P_1P_2 = ?$$

$$\frac{50}{P_1P_2} = \frac{26}{24} \qquad d = 25 \text{ cm.}$$

$$26\ (P_1P_2) = 1200$$

(P_1P_2) = 46 mm. Therefore each lens or bifocal segment must be decentered in 2 mm. for the reading distance.

Figure 2

This girl had a corrected visual acuity of 20/30 in the right eye and 20/30 in the left eye as measured on the E chart. Retinoscopy (under 0.5 per cent cyclogel) with deduction made for working distance revealed:

R +2.75 sph. +0.75 ax 90

L +2.50 sph. +0.75 ax 90

Her retinal correspondence was normal. Uncorrected muscle balance was

6 m. -26ET

25 cm. -26ET

With the following correction in both eyes, +2.50 spheres, add +4.50 which patient is wearing:

6 m. = 8ET

25 cm. = 10ET (through distant correction)

25 cm. = 2E (through bifocal segment)

Worth 4-Dot Test: 6m-5 dots (through distant correction); 25 cm. -4 dots (through near correction).

Figure 3

CONCLUSION

1. There are two important principles in the fitting of bifocals for children for accommodative esotropia:

   a. The top of the reading segment should come between the lower border and the center of the pupil.

   b. The segments should be decentered inward 2 mm. each for the average child of 5 to 7 years of age.

2. The invisible kryptok bifocal seems to be the most desirable bifocal.

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OBJECTIVE AND SUBJECTIVE TESTING OF VISUAL ACUITY IN AMBLYOPIC PATIENTS

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The testing of amblyopia presents a problem in any follow-up study. Since repeated visual acuity measurements are the only criteria for following the patient, it becomes imperative that such measurements be taken with as much accuracy as possible. This, however, is quite difficult, since there are only a limited number of subjective charts and perhaps more important, the examiner is usually quite anxious to demonstrate an improvement in the particular patient. The examiner is often prone to urge the subject on to such an extent that vague guesses are listed as definite answers and any vagueness is attributed to lack of cooperation on the part of the patient. As a result of this, after frequent office visits, the patient seems to be improving to a fair degree. Then, after a relatively long absence, the patient is again checked, and a marked decrease in visual acuity is noted. Often the subject may have actually retained whatever gain he had made and any loss is either of memory or skill in judging what answers the examiner wishes.

From the above, one would predict that changes due to this type of error in extremely poor acuities would be quite rare, since a change from 20/400 to 20/200 represents being able to see an object one half as large as the 20/400 figure, while a change of acuity from 20/40 to 20/30 means being able to see an object which is only different by 1/10 to 1/13.3 the size of the 20/400 figures.

To minimize the subjective element in testing acuity we have employed an objective means which has been previously described.[2] The purpose of the present paper is to compare the results obtained from testing a group of amblyopic patients with this apparatus and by standard subjective tests.

In this instance the objective visual acuity was measured by means of the presence of opticokinetic nystagmus. Opticokinetic nystagmus (train nystagmus) is present when a visible field is moved in front of a subject. This nystagmus has a slow and fast component. The slow component is the fixating or following motion, while the fast component is the corrective portion of the nystagmus.[1] The latter component imparts the noticeable jerk to the reflex, which allows the observer to determine easily whether the nystagmus is present or absent.

PROCEDURE AND APPARATUS

The subject was seated one meter in front of the field with the apparatus so adjusted that the subject's eyes were fixed on the center of the field. The field consisted of vertical lines printed on heavy paper which was moved horizontally between two rollers (fig. 1). The apparatus was electrically powered so that the examiner's complete attention could be focused on

Howe Laboratory of Ophthalmology, Harvard University Medical School, Massachusetts Eye and Ear Infirmary, Boston.

This work was conducted under a Fight for Sight Summer Fellowship of the National Council to Combat Blindness, Inc., New York.

the subject's eyes. The lines were arranged in diminishing thickness with corresponding separations.

The chart was started in motion and the subject's eyes were alternately occluded, each eye being observed during each group of the same sized lines. When nystagmus was noticed to be absent in one eye, the line thickness was noted, that eye was occluded and the other eye observed. If both eyes showed nystagmus with all lines at one meter, the test was then repeated at two and one-half meters. At this distance the smallest line was equivalent to Snellen 20/20. The smallest line at one meter corresponding to Snellen 20/45. If no nystagmus could be elicited at one meter, then the field was moved towards the subject to a distance of one-half meter.

The examiner did not know the visual acuity of the subject until the procedure was completed. After the procedure the examiner measured the Snellen visual acuity, and, as a double check, this measured Snellen acuity was compared to an acuity taken by another examiner.

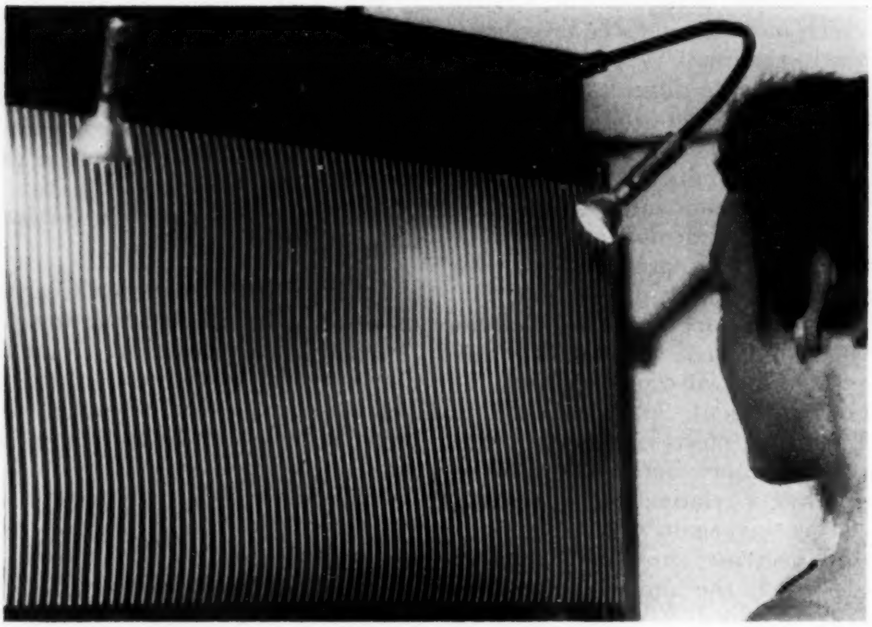

FIG. 1—Subject seated at the apparatus used for measuring objective visual acuity by means of the opticokinetic nystagmus.

RESULTS

The poorer objective visual acuities in these 26 cases were found to correspond closely with the subjective visual acuities, while the better visual acuities did not correspond with each other (fig. 2). The correlation coefficient was high, indicating that the discrepancy between the two types of visual acuity was a somewhat linear difference, but the spread of raw data indicates that this difference could not be predicted with enough accuracy to make a correction factor of any worth.

The correlation coefficient was calculated as follows:

$$N = 26$$
$$\Sigma X = 3{,}815$$
$$\Sigma X^2 = 789{,}823$$
$$\Sigma Y = 3{,}175$$
$$\Sigma Y^2 = 632{,}625$$
$$\Sigma XY = 682{,}475$$

$$r = \frac{N\Sigma XY - \Sigma X \Sigma Y}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\ [N\Sigma Y^2 - (\Sigma Y)^2]}}$$

$$r = +0.912$$

The present work demonstrates the usefulness of this means of measuring objective visual acuity. An objective visual acuity would seem to be the type of measurement of choice to use when following the treatment of patients with amblyopia, a treatment which is heavily weighted with subjective techniques.

The instrumentation used in this experiment was largely designed by Dr. Gorman,[2] being modified for use with older children and adults. This apparatus is not available commercially.

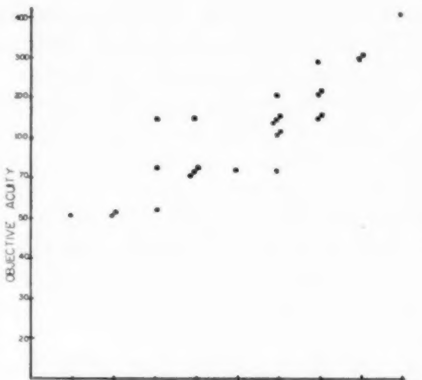

FIG. 2—Raw data indicating correlation between objective and subjective visual acuities of amblyopic patients. Subjective acuities are plotted by the customary fraction, while the objective acuities are plotted by the Snellen equivalent denominator.

SUMMARY AND CONCLUSIONS

1. The objective and subjective visual acuities of 26 patients with amblyopia who were undergoing treatment were compared. The objective visual acuity in the present study was measured by noting the presence or absence of opticokinetic nystagmus while a field of moving lines of diminishing width was presented to the patient. The subjective acuities were measured by means of standard Snellen charts.

2. Their objective and subjective visual acuities were of approximately the same magnitude at the grosser visual acuities; however, at the finer visual acuities there was considerable disparity.

3. It was concluded that objective visual acuity measurements are the measurements of choice in following the progress of amblyopic patients.

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A FOLLOW - THROUGH CHEIROSCOPE TECHNIQUE

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For the greater part orthoptic training is a subjective means of correction for strabismus. Although the examiner has technical knowledge regarding subjective responses, and can objectively present favorable conditions for subjective action, the inherent development is hidden to all except the patient.

This factor brings forth various psychological reactions from the parents, ophthalmologist and orthoptist, as well as the child. During the training period which limits a child to major amblyoscope techniques, the parents have to accept reports, and often with little assurance, that their child's eye condition is improving. This also applies to some extent to the ophthalmologist who, upon reexamining a child, finds little change in appearance from the original examination.

If properly supervised, the results of cheiroscope work can serve as a test for binocular vision. In our office cheiroscope training is looked forward to with the greatest of anticipation by patient and orthoptist and acts as a psychological stimulus. For at this time, the training leaves the passive stage and connects active training of hand-eye coordination with tangible subjective and objective results. It gives us another means of evaluation and has a comparative value which helps to indicate further corrective procedures.

However, cheiroscope training incorrectly instituted can be harmful and a misleading form of therapy. In all probability the cheiroscope is the most abused instrument used. To give a child cheiroscope exercises before he reaches binocular responsibility is like giving the child skating lessons before he learns to walk. Because a child can make a figure resembling the one used in the cheiroscope does not always indicate progress or that binocular vision is present.

The first binocular attempts to use the cheiroscope quite often are unsuccessful and frustrating, even to an adult patient. This situation is magnified in a child who may have an anomalous retinal correspondence, amblyopia, suppression and little or no established binocular pattern.

To prescribe cheiroscope exercises for home or office training, with the above conditions present, not only will delay progress, but create other problems. The majority of orthoptists are aware of these hazards, and many have worked out techniques for their individual patients with successful results.

It was my good fortune to be introduced to the cheiroscope by Miss Elizabeth Stark. The ingenious techniques she used on the cheiroscope made a lasting impression on me.

One of the cheiroscope techniques we use, which is a routine procedure, has proven beneficial in several ways. For a comparative record, about once a month the figure of a star is traced by the patient and the examiner and kept on file. Throughout the treat-

Presented at the Southern Regional Meeting of the American Association of Orthoptic Technicians, April 18, 1958, Houston.

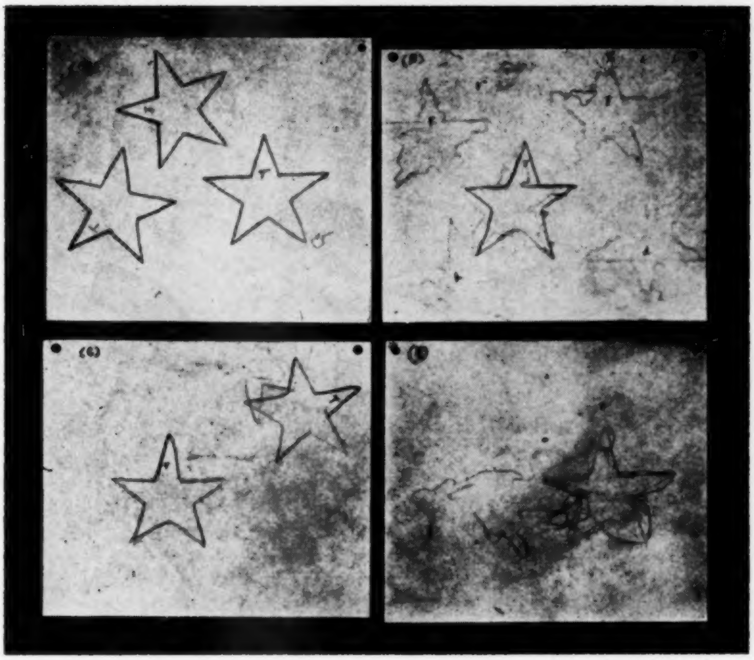


FIG. 1—(A) Binocular tracing on cheiroscope of reflected image by adult patient and examiner. Each had a normal muscle balance. Star figures are identical and tracings coincide.

(B) The same as (A) except patient was 5 years old. The wavy lines are those of a preschool child and do not affect the regularity of form.

(C) Patient's monocular tracing of cheiroscope figure which had been previously traced from reflected cheiroscope image by the examiner (center figure). In the upper right hand corner the light left incomplete figure was an attempt at binocular tracing for the first time by a 6-year-old child having treatment for the correction of accommodative convergent strabismus. The upper right tracing of the star is that of the examiner who has a normal muscle balance and was traced after the patient had fiinished tracing.

(D) Conditions similar to (C) except there is an additional monocular tracing by a 5-year-old patient on the examiner's.

ment, from the first to the last figure, we are able to follow and review, objectively, this subjective development of the patient, which is somewhat like the use of visual fields and roentgenograms. The black outlined figure of a star was selected for simplicity, yet provided exacting proportions.

After the figure of the star can be traced without effort, and the child has matured sufficiently to cooperate, the technique is advanced to increasing fusional range. For this part of the technique the examiner must have a normal muscle balance since the examiner traces a star alongside that of the patient's without moving the paper or mirror.

If an esophoria is present the patient's star will be to the left of the examiner's and conversely to the right in an exophoria, unless the patient is excessively accommodating and converging as sometimes seen in divergence excess. The distance between the top points of these two stars indicates the desired fusional range. The patient tries by dissociation practice to see the reflected image of the star move from the original sight toward the examiner's and fuse with the one traced by the examiner. This may be accomplished on the first attempt or may take months of practice.

The final step of this technique comes when the patient is able to

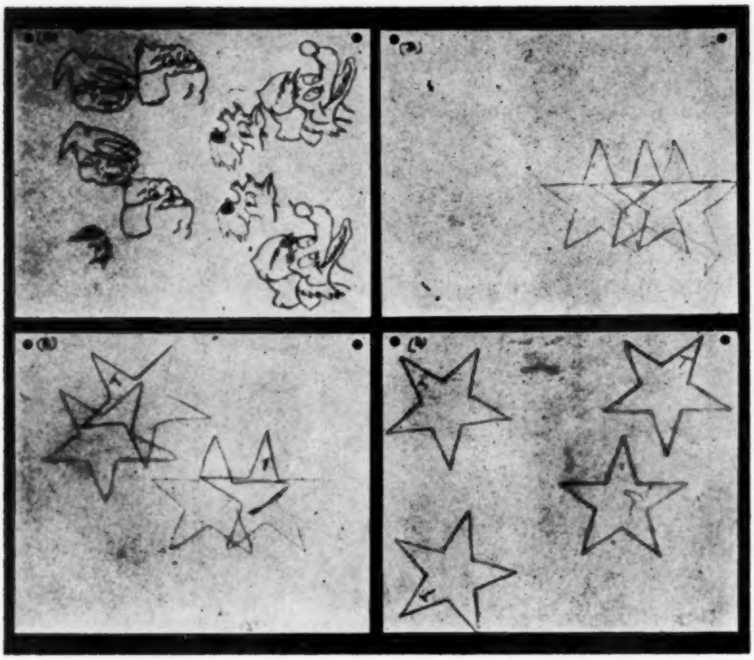


FIG. 2—(A) Duplicate figures for comparison. The patient traced without correction and with and without +7.75 spheres in cheiroscope. After correction of accommodative strabismus figures with detail are traced.

(B) Center star illustrating normal eye position. Left star showing position with eyes in maximum convergence and right star the maximum divergence in fusional range with a normal muscle balance.

(C) Right stars in normal positions, left stars in outward positions found in an adult patient with a divergence insufficiency before exercises. Muscle balance exceeded requirements for the Air Corps.

(D) After corrective exercises, divergence insufficiency no longer present. Star tracing of patient and examiner coincide. Patient's star traced before the one of the examiner.

maintain fusion with the stars while accommodating sufficiently to trace a line of the reflected star image on the examiner's star. This technique serves as a working guide and only has diagnostic value insofar as related to other findings.

Figures are traced with and without a +7.75 sphere in the cheiroscope. For additional interest, colored pencils are used. The child delights in making a favorite color selection from a set of twelve assorted shades. The examiner's choice of colored pencil contrasts to the patient's choice of color, usually in some darker shade or complimentary color.

With beginners, the examiner uses a black pencil. This gives the patient the fusional advantage of like shapes, sizes and color in attempting to fuse the black outlined star reflection with the star traced by the examiner. If there is difficulty in dissociating, the patient is instructed to use a yellow pencil for the first star traced and a dark purple for the second star, which is traced on the examiner's black one by dissociation.

Later further color interest may be had by using complimentary colors such as red for the examiner and green for the patient. Lines fused with these colors result in a colorless

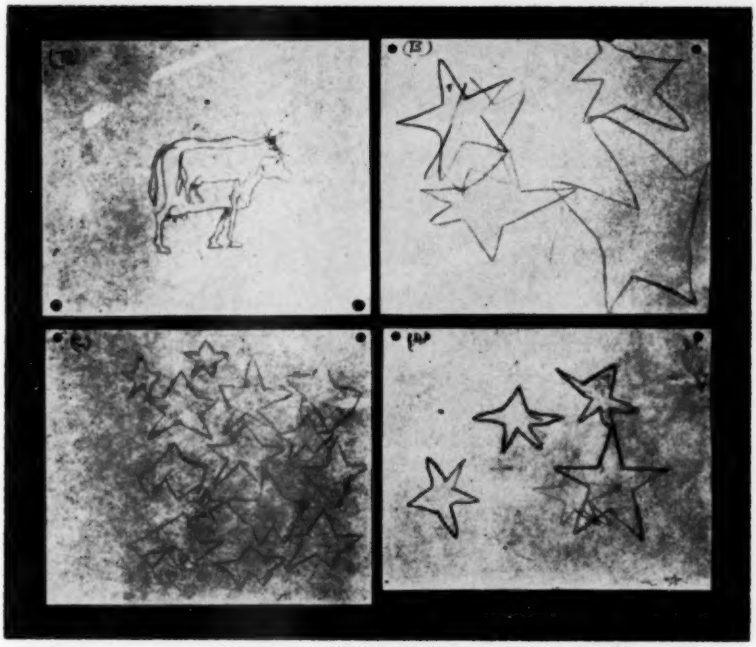


FIG. 3—Illustrations of monocular tracings. (A) and (B) figures larger than reflected image. Examiner's star in upper left of (B). (C) and (D) figures are smaller than reflected image. Examiner's star (D) to right. Note a small practice drawing of the patient's in the extreme right corners.

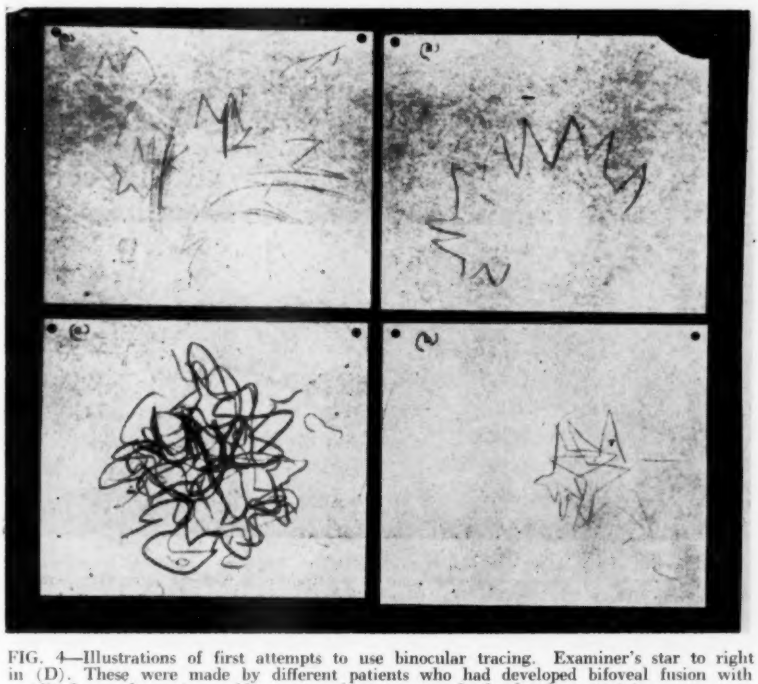
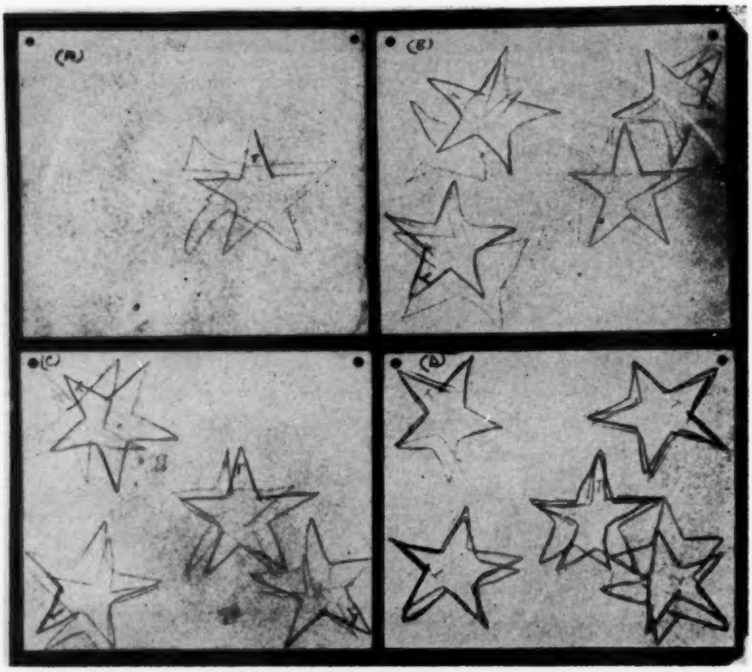
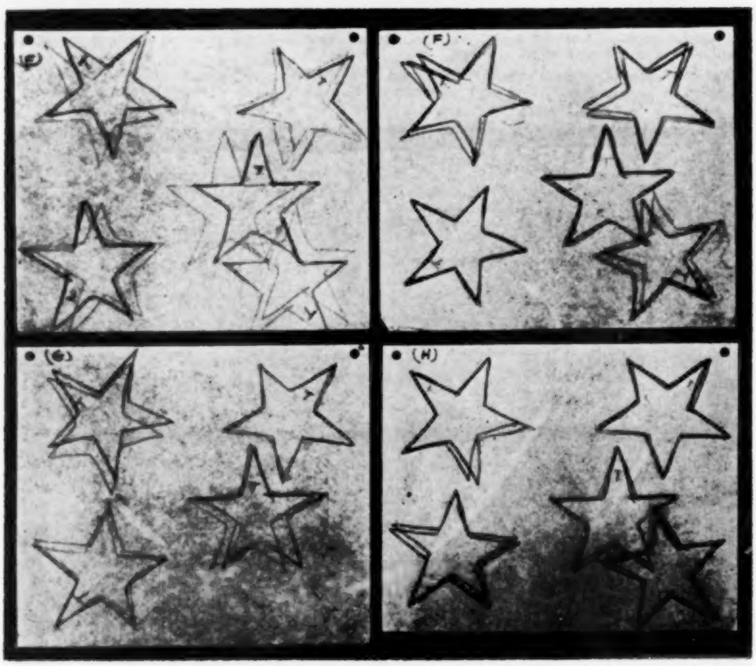


FIG. 4—Illustrations of first attempts to use binocular tracing. Examiner's star to right in (D). These were made by different patients who had developed bifoveal fusion with amplitude on the major amblyoscope and are now ready for hand-eye training.





FIGS. 5 and 6—Progressive developmental levels in binocular hand-eye coordination. Prior to correction a nonaccommodative convergent strabismus with an alternating sursumduction was present. The first star was traced when the patient was 7 years old and the last one when 18 years old. The examiner's stars are to the right of the patient's stars. (A), (B), (C) stars were traced within one month, (D) stars at the end of a year, (E) stars at the end of another year, and (F) stars at the end of another year, (G) stars were traced on a re-examination visit when the patient was 15 years old, and (H) stars when 18 years old. The continued improvement in binocular single vision development may be noticed in (H) by the definite and clear lines in tracing.

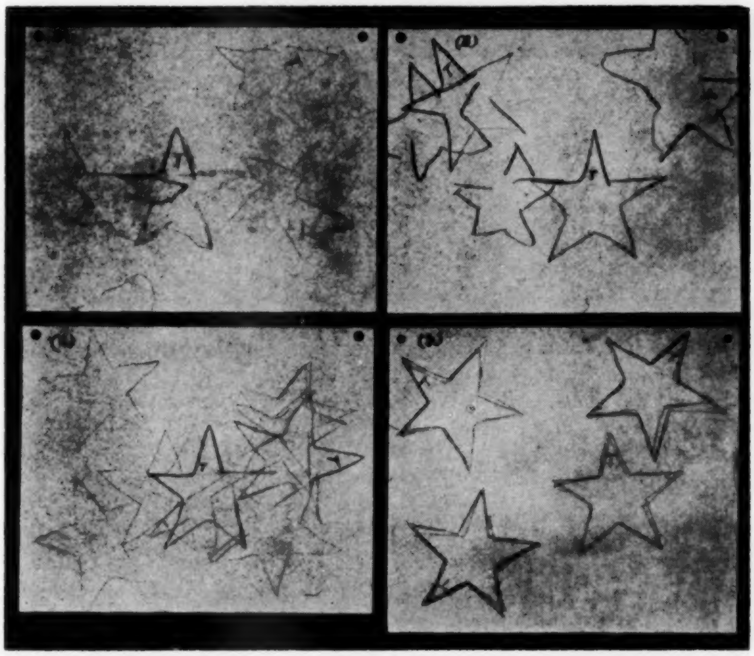


FIG. 7—Before corrective treatment, an accommodative convergent strabismus was present. These progressive illustrations were traced without a refractive correction and with a plus sphere in the cheiroscope. The examiner's stars are to the right of the patient's. The patient's stars were traced before the examiner's except the darker stars in (C). These were traced after the examiner's in an attempt to fuse the reflected star image with examiner's through dissociation.

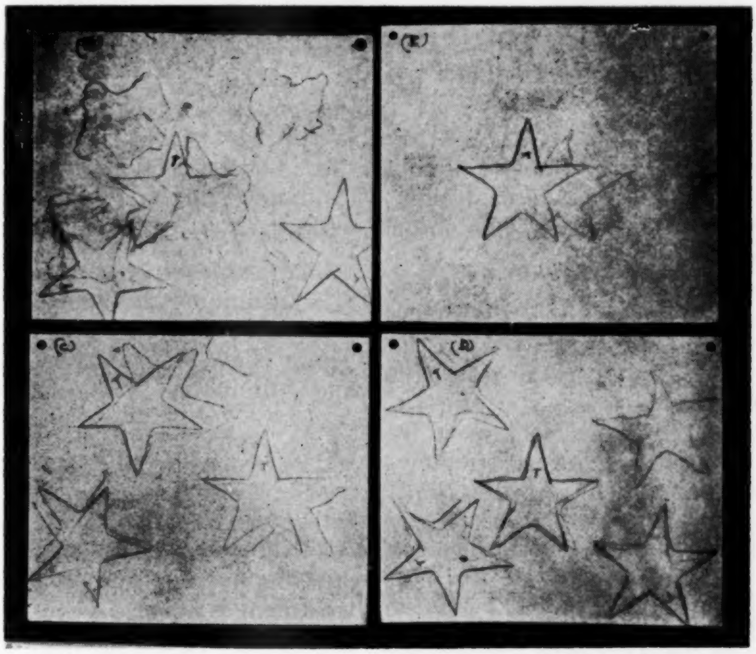


FIG. 8—Illustrations in the progress of a patient with divergent strabismus of the convergence insufficiency classification. (A) Examiner's star is to the left of the patient's first attempt to trace stars. In others, the examiner traced the stars before the patient, and the patient attempted to fuse the reflected star image with the examiner's in (B) and (C).

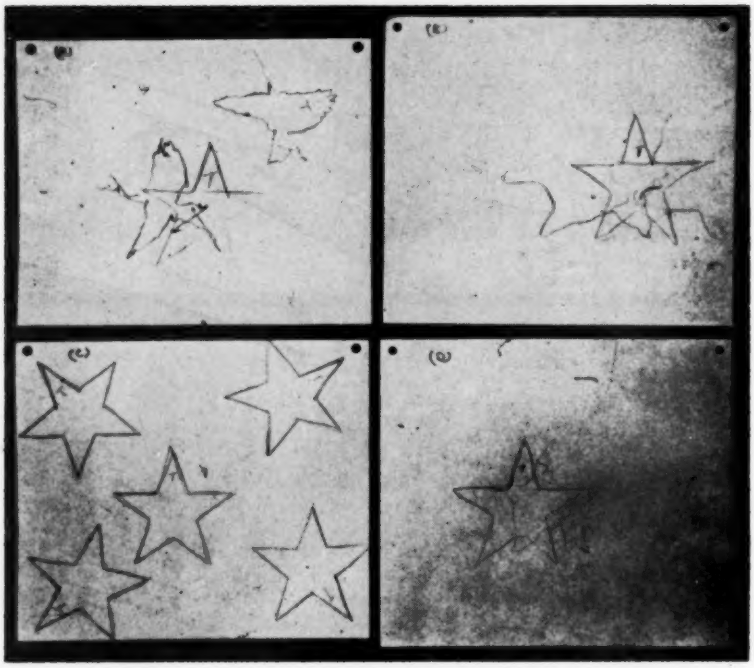


FIG. 9—Illustrations of tracings in divergence excess. In an excessive attempt to converge, the patient traced his star in (A) to the left of the examiner's when the plus sphere was used in the cheiroscope. The training in this type is to correct the excessive convergence. This work is begun by the examiner tracing a star and the patient attempting to fuse the reflected star image with that of the examiner's. Such an attempt is illustrated in (B). The examiner's star is in the center and the patient's tracing is first to the left and then to the right. The final successful result is shown in (C) where the two tracings coincide. Without the plus sphere the patient's star is to the right of the examiner's in (D) as it should be when exophoria is present.

black looking figure. The use of this color combination is especially effective after improvement has been noted, and the patient's star is no longer in an outward position. At this time the examiner will see the image of the reflected star directly upon the patient's and in tracing the star with a red pencil, the green star the patient has traced turns black as if by magic. This pleases the patient however old he may be! Also, it indicates to the examiner the success of the training.

This technique worked out so well during World War II with young men enlisting in the Air Corps that not one of them failed the examination when the combination of their own black star image reflection, and that of the examiner consistently formed one pattern.

The achievement and success of this technique, as with any accomplishment, presents certain problems. These, however, can be recognized and eliminated in the majority of cases.

The extent of the technique used depends upon the patient's maturity rather than age. It has been successful with patients as young as 5 years, but the average age to begin this treatment is about 6 years.

Usually, the first time a patient tries dissociation on the cheiroscope, it will not be successful and the result

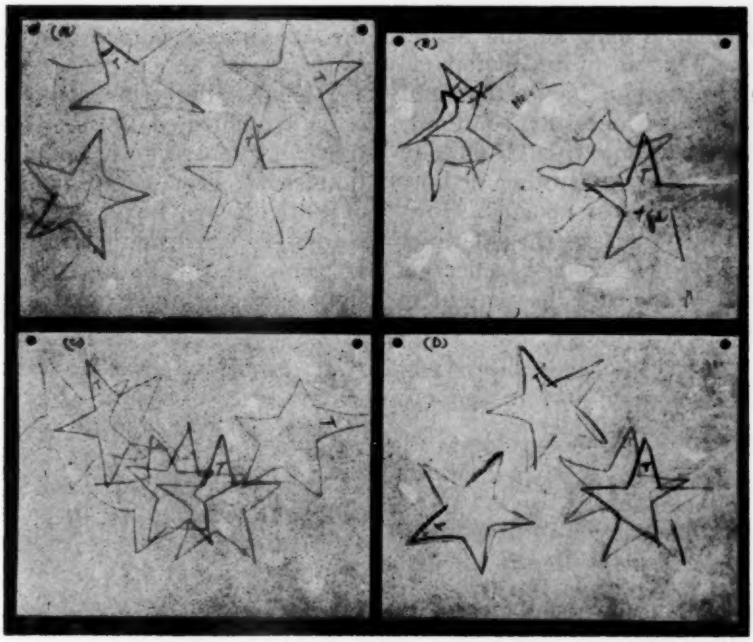


FIG. 10—In this illustration of a vertical deviation the examiner's stars are below and to the right of the patient's. An attempt is made in (C) to fuse the reflected star image with the examiner's. The progress of this development is shown in (D). The center right star is the examiner's, traced after the patient's tracing. The other two were also traced after the patient's tracing. The fusional range developed sufficiently to allow normal binocular function of the eyes.

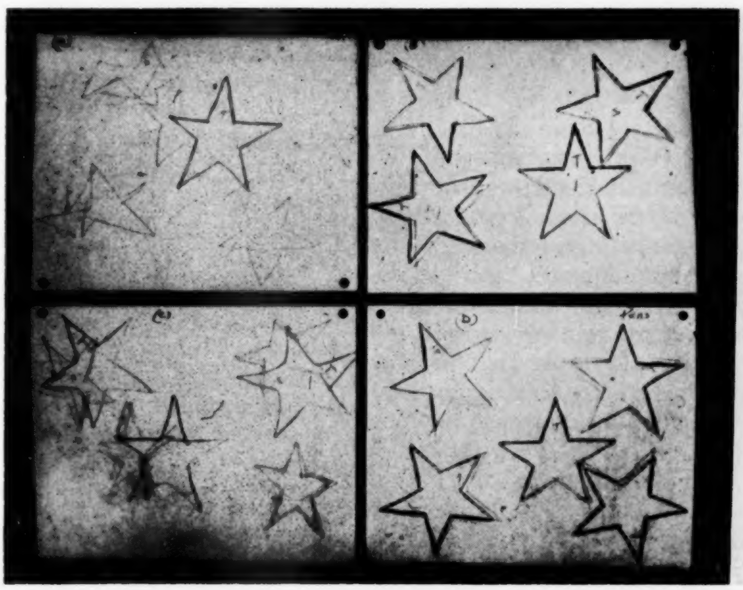


FIG. 11—(A) First tracings made by a patient 20 years old. The examiner's star is in the center with the patient's to the upper left side of the examiner's. (B) Last tracings by same patient. Three of the four tracings of patient and examiner coincide. Prior to correction there was an alternating esotropia present with an alternating sursumduction.

(C) First tracings of a patient 32 years old. Before correction there was a nonaccomodative alternating esotropia since birth, and an anomalous retinal correspondence. The examiner's stars are to the right of the patient's. (D) Last tracings by same patient. Slight difference in patient's and examiner's tracings. Lines are clearer and contour improves with binocular development.

is a monocular tracing of the examiner's star. This is quite obvious to the examiner and further instructions in dissociation are necessary. Patients using this technique should already have learned from their other orthoptic exercises how to dissociate. However, to simplify matters, the examiner can trace the star image reflection first, and then instruct the patient to fuse the star image reflection seen with the examiner's before attempting to trace one on the paper.

I believe that cheiroscope training is contraindicated until bifoveal fixation is present. The following illustrations have been made from records of patients we have seen and are shown to illustrate pertinent factors. In some of the figures the lines are light as the original tracings were not retouched.

THE A AND V SYNDROMES

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IN studying a muscle problem, we usually measure the amount of deviation in the primary position and in the six cardinal positions. Recently, attention has been focused on deviations in upward and downward gaze with the eyes fixing an object in the vertical midline.

For example, a patient has 15 diopters of intermittent exotropia in the primary position for both distance and near. On upward gaze the strabismus measures 40 diopters but on the downward gaze it is only 8 diopters. When the patient is examined in the six cardinal positions of gaze, no vertical anomaly can be uncovered. This patient fulfills the criteria for the V syndrome. The A syndrome, associated with exotropia, occurs when exotropia is greater on downward gaze that it is on upward gaze.

In esotropia, we may find similar conditions. If the esotropia is greater on the upward gaze and less on downward gaze, the patient has an A syndrome. For example, a patient has esotropia of 8 diopters for distance and near in the primary position. When examined in the six cardinal positions the esotropia remains constant and no vertical deviation can be elicited. On upward gaze, he has 25 diopters of esotropia but on downward gaze only 6 diopters of esotropia. This patient has an A syndrome. Conversely, in the presence of the V syndrome, esotropia is greater on downward gaze and less on upward gaze.

In these syndromes, upward and downward gazes affect the degree of horizontal strabismus. No vertical element can be uncovered, or if a slight hypertropia is present, it is secondary and of little consequence.

A certain amount of difference in measurement is to be expected in the average case of strabismus on upward as compared to downward gaze. Exotropia is usually greater when the patient fixates an object above the horizontal midline than it is when the patient fixates an object below the midline. The converse is true for esotropia, the latter being greater on downward than on upward gaze. These differences are usually under 10 diopters.

CAUSE

The mechanism for the production of these syndromes is not known.

Urist[4] emphasized the importance of the lateral recti in the upper field and the medial recti in the lower field. Thus, an esotropia increasing in downward gaze (V type) is said to be due to medial recti overaction, whereas an esotropia increasing in upward gaze (A type) is due to lateral recti underaction. Exotropia increasing in upward gaze (V type) would be due to overaction of the lateral recti, and exotropia increasing in downward gaze (A type) would be due to medial recti underaction.

Breinin[1] has carried out electromyographic studies of vertically noncomitant horizontal strabismus to determine the role of the horizontal and

Presented at the Midwest Regional Meeting of the American Association of Orthoptic Technicians, May 5, 1958, Minneapolis.

vertical muscle. He found that the vertical muscles showed only the expected action in their fields of action.

The horizontal recti, however, in nearly all of the four types described, showed innervational changes corresponding to the deviation. Thus, in V type exotropia, the lateral recti increased and the medials were reciprocally inhibited in upward gaze. In A type exotropia the identical changes occurred in downward gaze. Corresponding alterations appear in A and V esotropias. Breinin believes that the horizontal recti must play some part in the varying angle of strabismus. In only a few cases of A or V syndromes did the horizontal recti exhibit no particular change in vertical gaze. In these cases the vertical non-comitancy must be ascribed to the vertical muscles. Thus it would seem that these syndromes are caused by combined overactions of the horizontal recti and the vertical muscles.

Bilateral vertical recti involvement have been held to be the cause of marked alterations of the horizontal deviation in direct upward gaze compared with direct downward gaze. Some believe that this phenomenon is due to secondary involvement of the vertical recti consequent to the horizontal deviation. Others believe that it is due to primary underaction of the vertical rectus muscles with secondary deviations or contractions of the obliques.

Some of the patients exhibiting this phenomenon undoubtedly show underaction of the vertical recti, even in monocular rotation, with marked overaction of the obliques.

It is believed that the secondary overaction of the oblique muscles is the major factor. Bilateral oblique overaction is encountered as an accompaniment of bilateral vertical rectus paresis, or a sequela to such a bilateral paresis, which pre-existed and from which the patient subsequently recovered.

In exotropia associated with the A syndrome, overaction of the superior obliques acting as external rotators would thus cause an increase in the angle of squint on downward gaze. In a similar manner, the inferior obliques would rotate the eyes outward in upward gaze, and exotropia would increase if the patient has the V syndrome. A similar hypothesis has been utilized to explain these syndromes associated with esotropia, although it would seem that secondary overactions of the obliques are less effective in esotropia than in exotropia.

Jampolsky[3] has pointed out that in exodeviation of an eye, especially in deviations of large degree, there tends to develop a contracture and overaction of one or both the oblique muscles. He believes that the slackening of the oblique muscles, occurring when the eyes are in exoposition, favors contractures in these muscles and that these contractures also result in an increased abduction component in the action of the obliques. This, in turn, would cause the exodeviation to become greater.

Against this view, Burian[2] pointed out that overactions of the oblique muscles are also frequently seen in esodeviations, anomalies in which Jampolsky's conjectures certainly do not apply. Also, the action of the oblique muscles in horizontal rotations is slight, and one wonders whether it is of clinical significance even in the presence of contractures or overactions of these muscles.

These explanations are still tentative but perhaps as further data are gathered we will obtain more definite information about which group of muscles is chiefly responsible.

MANAGEMENT

While no final answers have been agreed upon concerning treatment of these conditions, certain tentative ideas about treatment can be mentioned.

The treatment which has been suggested and attempted is surgical. This is a departure from the conservative rules of strabismic surgery, because operations on the vertical muscles are recommended for the correction of strabismus which is strictly horizontal.

The clinical management of patients exhibiting differences in the horizontal deviation in upward versus downward gaze may be summarized as follows:

1. Mild degrees of the anomaly may be ignored, especially if a fusional result is not probable, since the lids cover the defect in downward gaze.

2. Moderate degrees of alteration in the horizontal deviation in upward versus downward fields of gaze may be improved by performing appropriate bilateral surgical procedures upon the horizontal rectus muscles. Initial horizontal muscle surgery has been urged by Urist to obtain vertical comitancy.

Breinin states that his preliminary observations indicate it is best to surgically attack the horizontal muscles before the vertical ones. When gross vertical imbalance exists, however, classic rules must still be followed.

Others who consider the vertical rectus muscles important in these variations recommend resection of the vertical rectus muscles as an initial procedure to attain vertical comitancy. Bilateral resection of the vertical rectus muscles, although enhancing the percentage of satisfactory results in the management of exodeviations, does not materially affect the alteration of horizontal deviation in upward versus downward gaze.

Since bilateral surgical procedures on the vertical recti do not materially affect the horizontal deviation shift, some consider the bilateral oblique procedure. Recession of both inferior obliques is recommended for correction of the V syndrome associated with exotropia.

Opinion is more varied concerning the treatment of the A syndrome associated with exotropia. Weakening of both superior obliques by tenotomy has been tried. Advancement and resection of both inferior obliques has its advocates. Surgical operation on the vertical muscles has been performed alone or in conjunction with treatment of the horizontal muscles depending on the amount of exotropia present in the primary position.

According to Jampolsky,[3] bilateral superior oblique tenotomy is to be considered.

1. Only for children faced with potential loss of fusion in the primary position due to increasing exodeviation.

2. Children demonstrating unmistakably good sensory-motor fusion.

3. With near orthophoria in direct upward gaze.

4. Progressive and increasing intermittent exotropia which is becoming more constant in the primary position of gaze.

5. With constant exotropia in direct downward gaze which is at least 45 prism diopters more exodeviation than in direct upward gaze. A chin-down position may occur in order to gain fusion in the primary or direct upward field of gaze.

6. The presence of approximately equal, markedly overacting superior oblique in children with these specific

indications may justify bilateral superior oblique tenotomy.

The exodeviation in downward gaze may be expected to diminish by 45 prism diopters, with little effect upon the horizontal deviation in direct upward gaze as a result of complete tenotomies of the superior oblique tendon.

Children with these specific indications who have not been treated have gradually lost binocular vision in all fields of gaze because of the marked horizontal noncomitancy.

to consider the possibility of operation on some other muscles where danger of complications is not so great.

It can be demonstrated that the adducting power of a vertical rectus can be increased by shifting the insertion medially. Such a procedure does not create a serious torsion problem as seen in an oblique, and in addition does not lessen the vertical action of the vertical rectus sufficiently to create an underaction.

Working on this basis, I have used this procedure in several cases of exo-

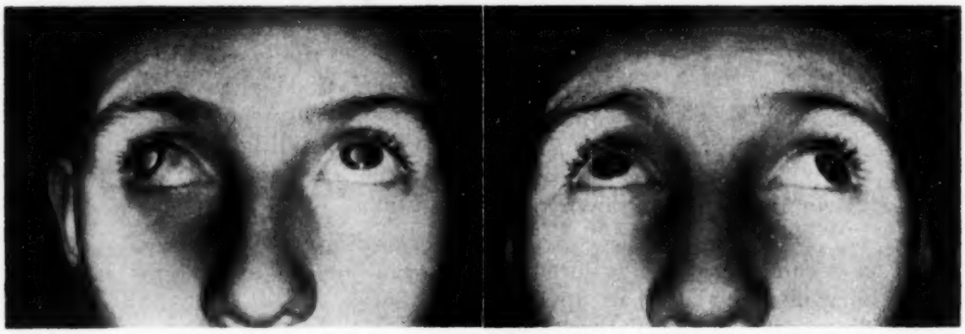

FIG. 1—Case 1 before operation.

Surgical correction of A and V syndromes associated with esotropia has not received as much attention as those with exotropia, and here again some advocate surgical operation on the obliques. The following procedures have been recommended: In cases of esotropia with the V syndrome, weaken the inferior obliques either alone or with resection of the lateral recti when the primary esotropia justifies it. In cases of esotropia with the A syndrome, resect and advance the inferior obliques, either alone or with resection of the lateral recti. Rather good results have been claimed from tenotomy of the superior oblique.

Because of the serious complications which may follow a weakening operation on the obliques, it seems advisable

tropia in which the A or the V syndrome was present. In these cases, the superior recti or the inferior recti were shifted medially 5 mm. On a whole, the results were satisfactory. It seems possible that a greater shift medially would create a greater adduction effect than obtained in my cases.

Case 1

A 12-year-old boy had had exotropia since early life. A bilateral recession of the lateral recti had been performed two years previously. My first examination revealed an alternating exotropia of 15 diopters in eyes-front position, 6 diopters in downward gaze and 35 diopters in upward gaze (fig. 1). Fusion was not present.

FIG. 2—Case 1 after operation.

Both superior recti were shifted 5 mm. medially. Three months after operation, the measurements were 10 diopters in eyes-front, 5 diopters in downward gaze, and 15 diopters in upward gaze. Although the eyes were not parallel, the cosmetic effect was satisfactory (fig. 2).

Case 2

A 5-year-old girl showed an alternating exotropia which was first noticed at two years and had been progressively increasing. When examined, she showed in eyes-front position an alternating exotropia of 30 diopters for distance and 20 diopters for near (fig. 3).

Both lateral recti were recessed 5 mm. Three months after operation, (fig. 4), measurements showed for both distance and near 8 diopters of exotropia in the eyes-front position. In upward gaze, 5 diopters of exotropia were present but in downward gaze, 30 diopters of exotropia were measured. Both inferior recti were shifted medially 5 mm. Three months later measurements showed in eyes-front position 8 diopters of exotropia, in upward gaze 5 diopters, and in downward gaze 12 diopters. Orthoptic training was recommended to develop fusion which was very weak.

FIG. 4—Case 2 after operation.

Case 3

Another 5-year-old girl came because of exotropia which had been present since birth but was becoming progressively greater (fig. 5).

FIG. 3—Case 2 before operation.

FIG. 5—Case 3 before operation.

FIG. 6—Case 3 after operation.

In eyes-front position the deviation was 35 diopters of exotropia for distance and 15 diopters for near. Bilateral recession of the lateral recti was done. Three months later the following measurements were noted: Exotropia of 15 diopters in eyes-front position for distance and 8 diopters for near. In upward gaze, exotropia was 6 diopters but in downward gaze it was 30 diopters.

Bilateral shifting of the insertion of the inferior recti medial 5 mm. was performed. Three months later, exotropia of 5 diopters was present in upward gaze, 10 diopters in eyes-front position for distance and 15 diopters in downward gaze (fig. 6).

CONCLUSION

In general, our impressions and ideas about the A and V syndromes are still in the formative stages, and further experience and study are necessary before we can draw more definite conclusions about the pathogenesis and treatment of these conditions.

It cannot be stressed too strongly that tenotomy of the superior oblique muscle in a seeing eye is an irreparable procedure and that its indications are rare. Cyclodeviations would be introduced, which as we all know, are a source of greatest difficulty to many patients.

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MANAGEMENT OF RECURRENT AMBLYOPIA

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A considerable number of patients with serious amblyopia (e.g., a visual acuity of 20/200) are significantly improved with proper occlusion or antisuppression therapy of the conventional type, only to have the vision regress to the original level of impairment when the treatment has been stopped. This may happen in spite of the most conscientious efforts on the part of the ophthalmologist to maintain good vision.

It is well known that this vision is recoverable if therapy is not unduly delayed. Wheeler[6] believes that the vision in a previously amblyopic eye can be regained later if the regression did not start before the age of 6 years. Fowler[3] states that amblyopia may recur if the child is not watched until he is 8 years old. I think that there is no fixed age limit as to when vision is recoverable and when no regression has to be feared. Much depends on sometimes undetermined factors such as strength of dominance of the leading eye, the patient's awareness of his problem, and his desire to overcome his handicap.

Costenbader[1] states that single binocular vision with sufficient fusion amplitudes will secure not only permanent correct alignment of the two visual axes but also good visual acuity in either eye. There are, however, many patients in whom single binocular vision cannot be achieved: patients with small angle esotropia and anomalous retinal correspondence, or patients with vertical deviations of higher degree, or patients who do not give prolonged cooperation. There are, furthermore, according to Swan and Laughlin[5] patients who, due to peripheral fusion, have single binocular vision even in the presence of a central scotoma.

In spite of these adverse influences, it is certainly possible to keep the acuity in the previously amblyopic eye at the best attainable level if the patient is routinely and frequently checked. However, because of change of residence or lack of understanding of the importance of follow-up, or because of the expense involved in routine frequent checkups by the ophthalmologist, many of these patients will eventually stop coming and end up with a vision not too far from their original low level. This misfortune might have been avoided if a simple routine treatment had been undertaken.

Patients with fixed amblyopia ex anopsia obviously are just as handicapped industrially as though they had gross organic lesions of the eye. Downing[2] reports that among 60,000 selectees for the U.S. Army, 1,920 had amblyopia, and that these cases formed 66 per cent of all the cases of monocular visual loss in his series. Irvine[4] found one per cent of 10,000 Air Corps personnel had amblyopia ex anopsia. Twenty per cent of this one per cent showed obvious strabismus. With the increased emphasis on

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good vision in either eye in industry, the failure to develop and maintain the best possible vision in an eye may change a person's whole outlook as to vocational opportunities.

Therefore, it seems desirable to outline a simple routine suitable for a school-age child, 7 to 15 years old, in which, with the aid of his parents, he can check his own vision and institute treatment promptly when indicated. I am referring here to the child with amblyopia who has already been "through the mill" along with his parents and who knows something about the problems and techniques of checking visual acuity and treating amblyopia. The following home routine includes (1) checking visual acuity at regular intervals and (2) reinstituting simple treatment as indicated.

Checking Visual Acuity at Home

As test objects, the patient can either be given letters obtained from cutting up a Snellen chart, or charts made with rubber stamp E's of 20/20 or 20/30 size. The parent has to be instructed at which distance he should see the symbols with his amblyopic eye. The parent can then check the child's acuity at frequent and regular intervals, e.g., once a week, as part of a strict routine.

Reinstituting Simple Treatment

As long as the visual acuity remains at the desired level nothing need be done. As soon as a minimal impairment is noticed, the patient can use one of the many types of training for the amblyopic eye which had been used during the period of intensive treatment. He may use full-time or part-time occlusion, atropine, nail polish, Scotch tape or Permafilm on the lens of the dominant eye, television clip, or many others. He may also resume some of the exercises he had been doing: red tracings, cheiroscope drawings, stereoscope, or orthofusor.

Only if he is unable to improve his visual acuity (which very rarely occurs if the treatment starts immediately after the impairment of acuity has begun) must he come to the office. Conscientious patients and parents welcome this arrangement, since it eliminates frequent visits to the ophthalmologist. It also gives a large share of responsibility to the patient. This, for an intelligent individual, is always stimulating.

I do not suggest that a follow-up by the ophthalmologist or orthoptist should be given up altogether. But this routine relieves the patient from the feeling that he has to come and pay for unnecessary visits and relieves the ophthalmologist from the need of frequent routine checks. Furthermore, at the time when the intensive treatment is finished and the patient is switched to the outlined home routine he, his parents, and the ophthalmologist have the satisfaction that the main part of the job is done, that the conventional treatment does not have to be continued indefinitely. This thought lifts the spirits of all persons involved.

SUMMARY

A simple routine is outlined for early detection and home treatment of recurrent amblyopia. This procedure is designed to supplement examinations by an ophthalmologist and consists of: (1) checking of the visual acuity by the patient's parent at weekly intervals; (2) reinstitution of treatment as soon as a slight impairment of acuity has been detected. In this way serious regression of visual acuity and the development of a fixed amblyopia can be avoided.

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BAR READING AS A HOME EXERCISE

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Bar reading is one of the common techniques used in orthoptics to overcome suppression and to increase fusional endurance at the reading distance, once it is mastered. It is considered a perfect physiologic skill, since the patient uses physiologic diplopia as well as his accommodation and convergence to break up suppression.[3]

Bar reading is usually difficult to learn, but when mastered it is easy to do. It must be taught carefully; otherwise, the patient will perform the exercise so carelessly that it will be of no benefit to fusion. The orthoptist will usually find that the time spent in teaching the technique is very gratifying.

When bar reading is done correctly, the page appears divided into five sections: (1) the left margin, (2) transparent left bar (seen by the right eye), (3) a clear space of printed material between two bars, (4) transparent right bar (seen by the left eye), and (5) right margin.[1]

TEACHING METHODS

As prerequisites, the patient must be old enough to read and he must be able to recognize physiologic diplopia. This being so, he should begin by holding his printed material at the regular reading distance. A bar less than half an inch wide is placed in front of the eyes, midway between the nose and book. The patient fixates a word on the page. If he fuses, he will recognize two transparent bars which do not interfere with the print, for the words can be seen "through" the bars. If he suppresses, he will see only one bar and it will appear solid, completely hiding the words which it covers.[1,3]

In the beginning stages of bar reading, the patient must be encouraged to keep his eyes fixed steadily on one printed target and try to maintain the two bars over a period of time; for example, while counting to 100. He must also be taught the location of the two bars in relation to his eyes, so that if he loses a bar he will know which eye he suppresses. The bar should never be moved. The transparent images of the bar should retain their location constantly on the page, and there should be no movement of the head or book. If there is no suppression, the bars will appear very real and definitely located.[1]

If the patient moves his head, the bar, or the book even slightly, suppression is present. If he moves the bar from one side of the page to the other, alternation is taking place. In early training, particularly with children, it is sometimes wise to hold the patient's head and watch his eyes as he bar reads, for in this way the orthoptist knows what the patient is doing without relying on him for an answer.[3] Some children at first will not recognize diplopia or two bars, but will report that the bar is "misty," or that he can "see the words through the bar." This is an indication that he is fusing.[2]

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When it has been established that the patient can maintain two bars with ease, it is helpful to begin reading the words down the page rather than across, observing all the words between the two bars, then all the words "through" the left and right bars; then, skip around from one area of the page to another as requested, constantly keeping two bars. When this exercise becomes easy, the patient is ready to attempt lateral reading.[1]

The patient should be encouraged to do all his reading with the bar until he reads binocularly with ease. At first, it should be done in short sessions until he is well adapted to fusion experience, for if done over too long a period he may complain of tired eyes and lose interest in the exercise. As fusion skill improves, the time can be increased until he can bar read for over an hour at a time. It is recommended that large print be used at first, gradually working up to the print the patient uses in his school textbook.[1,2] It is believed by some orthoptists that no patient with strabismus should be considered cured unless bar reading can be carried on successfully.[1]

INDICATIONS

Bar reading can be given to stimulate fusion in patients with esophoria and exophoria. The purpose of this exercise is to strengthen the fusion faculty by increasing the vergences.[3] A patient with exophoria must increase his convergence if he bar reads correctly. One problem of patients with accomodative esophoria is maintaining fusion at the reading distance. Bar reading serves as a good exercise if one is able to establish fusion at near. It is particularly effective in the final stages of treatment. If the patient is not already wearing bifocals, it may be necessary to give an additional plus one or plus two diopter spheres at first to enable him to read without excessive convergence. As progress is made and smaller print is mastered, the additional correction should be reduced.[2]

TYPE OF BAR

Various types of bars have been designed. Some are made to fit the head; others are to be held in the hand. A common model is the zigzag type which is held on the bottom of the page by the thumb, which also must help to hold the page.[2] One of the requirements for performing the exercise well is maintaining a stationary bar. For the average child, it is difficult to hold a bar perfectly

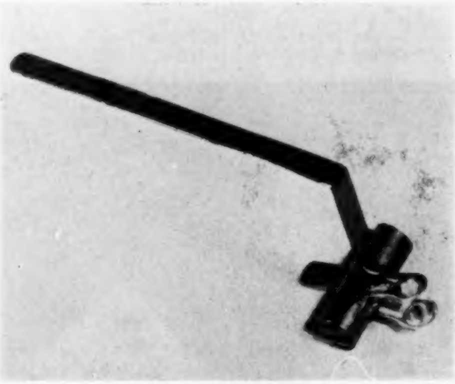

FIG. 1—A bar attached to a paper clamp. The short end of the bar fits tightly into the same opening as the top handle of the clamp.

straight over a period of time as the fingers become cramped and tired, and this causes the patient to relax his grip so that the bar shifts its position. Concentrating on fusion is in itself enough to expect from the patient, without the added burden of holding the bar in one position. This is particularly true if fusion is to be practiced over a long period.

Figure 1 shows a bar which is attached to a paper clamp. It has been found that the short end of the bar fits tightly in the same opening as the top handle of the clamp. The clamp

is then attached to the bottom of the page or book (figs. 2 and 3) so that the bar falls along the center of the page and remains in place while reading.

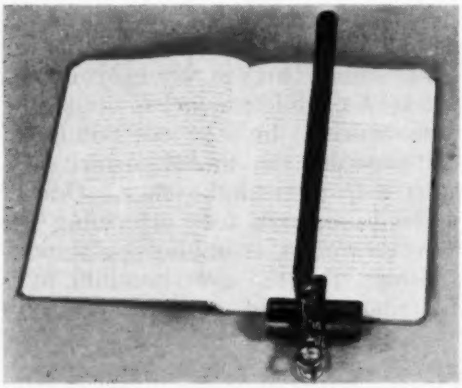

FIG. 2—The paper clamp, with the bar, is attached to the bottom of the book.

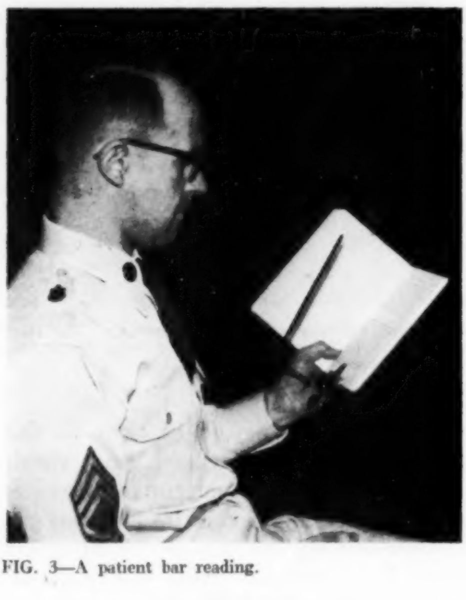

FIG. 3—A patient bar reading.

SUMMARY

1. Bar reading is an excellent home exercise to help overcome suppression and to increase fusional endurance at the reading distance, since it can be carried on over a long period of time.
2. Bar reading utilizes the skills of physiologic diplopia, accommodation, and convergence to perform the exercise correctly.
3. Bar reading can be prescribed for any patients with phorias who are likely to suppress, since it helps to strengthen the fusion by increasing the vergences.
4. As prerequisites to bar reading, the patient must be old enough to read; he must recognize physiologic diplopia; he must have some fusion at the reading distance.
5. For bar reading by patients who are not wearing bifocals, it may be necessary to give an additional plus one or plus two diopter spheres in early training so that they can stimulate accommodation without overconverging.
6. In bar reading, any movement of the head, the bar, or the book indicates that the patient suppresses.
7. At first, the bar reading exercise should be done in short sessions; but, as fusion skill improves, the time should be increased until the patient can bar read over an hour at a time with ease.
8. Since one of the requirements for performing the bar reading exercise well is maintaining a stationary bar, it is considered helpful to attach a paper clamp to the bar and adjust the clamp to the bottom of the page or book so that the bar remains in place while reading.

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VISUAL PROBLEMS

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Patients with reading problems are not infrequently seen by an ophthalmologist or orthoptist, and they present a well defined entity. Since these symptoms are rather vague they may easily be overlooked if the examiner does not keep the possibility of their existence in mind.

HISTORY AND COMPLAINTS

Often the youngster will be getting progressively worse reports from school in the third or fourth grade although he had done well in the first or second grades. Many have specific reading difficulties and they may show more or less pathologic behavior patterns. They complain about fatigue and dislike for prolonged close work.

OPHTHALMIC FINDINGS

The eye examination usually reveals no disease: there is often no significant refractive error or muscle imbalance: near point of convergence is most often good. Also the findings on the major amblyoscope show normal binocular functions, no suppression and sufficient fusion amplitude. A careful examination, however, may reveal that the patient is not able to *maintain* binocular fixation, particularly at the reading distance. This inability to sustain binocular fixation in prolonged reading is a characteristic and significant finding.

Another factor in these patients is a certain relative lack of maturity of their eyes, which may not have yet reached the level that other children of the same age group have attained. They are, therefore, less capable of meeting the demands of the regular school routine. In order to understand the significance of this problem we have to recall the stages of development of a normal eye.

The anatomic development of the eye is by no means complete at birth. The eyeball continues to mature until the child is about 8 years of age.[5] During this period there is a progressive increase in the size of the orbits, a reduction in the divergence of the orbital axes, an increase in the length of the globe itself and a number of changes within the eyeball proper. These anatomic alterations as part of a maturing process are essential before the eyes can begin to be capable of the complex functions involved in reading.

In the physiologic development of the eye much depends on the proper conditioning of the reflex mechanism which is so essential to comfortable, efficient use of the eyes. There are innumerable obstacles which may interfere with the full maturation of a normal binocular reflex mechanism. Of particular importance in this consideration is the full development of the vergence reflexes in order that convergence can be maintained for prolonged periods of reading. In view of the complexity of the adjustments required, it is small wonder that some children lag in the full attainment of a mature reading facility.

ORTHOPTIC EVALUATION

When checking a patient with the history of visual problems the examination should emphasize certain features. Visual acuity must be checked at distance and near, Worth lights test given at distance and near, and an adequate time for the proper response should be allowed. Near point of convergence and near point of accommodation have to be measured. Tests for the dominant eye must be done. The examination on the major amblyoscope reveals the quality of fusion and the kind of recovery, etc., using first peripheral and then foveal targets. The binocular stability should be tested as follows: the troposcope arms are locked at zero, the patient is required to fuse similar peripheral slides; when fusion is attained the size of the targets is diminished until finally 3 mm. targets can be fused without suppression. Minus lenses are then gradually added in half diopter increments until the patient is no longer able to hold clear vision and fusion. In this latter procedure the relative accommodation is stimulated without changing convergence.

Further instruments recommended for examination include the Telebinocular on which the Keystone phoria test can be performed for distance and near, the fusion test at distance and near, checking various grades of stereopsis. Also helpful tests are the Keystone fusion progress series and the Spache reading test in which even first graders may supply valuable information.

TREATMENT

Treatment may suggest itself: it must give the child good fusion reserve and the ability for sustained use of his eyes at any necessary distance. Bar exercises (physiologic diplopia) are very useful; one special type of bar exercise seems particularly helpful to the child with visual problems: a long strip of paper is used on which various symbols for a non-reading child are drawn, e.g., a solid circle, star, cross, triangle, square crescent moon, etc.

The child has to be taught to "frame" these objects one after the other, making certain that he begins at the left side and progresses slowly towards right, framing each symbol. Thereby he practices not only sustained binocular use of his eyes, but learns also (often for the first time) to make the gradually progressing movement of the eyes from left to right that is essential for reading.

If this exercise can be successfully done without suppression, the drawings may be replaced by E's in various positions and later by numerals and finally with letters or simple words. This should be practiced very carefully. Other helpful instruments for these patients include the cheiroscope, the Walraven separator, various types of disparators and the metronoscope.

SUMMARY

Visual problems manifest themselves in reading difficulties and behavior problems and in the inability to maintain prolonged close work. The clinical manifestations are usually minimal except for the difficulty in maintaining binocular vision for prolonged periods at the reading distance. Treatment is designed to increase the fusion amplitudes and sustain fusion. Reading exercises which utilize an awareness of physiologic diplopia may be particularly helpful.

CONCLUSIONS

Reading problems are usually the result of multiple factors and their very complexity suggests that the treatment be left to the reading teacher. The orthoptist, however, may have a significant part to play in the rehabilitation of this child and should therefore be thoroughly familiar with the diagnosis and treatment.

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DIVERGENT STRABISMUS

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Patients with divergent strabismus are both interesting and challenging. Some of these patients may have normal visual acuity and good fusional amplitude while being examined in the office, but they will still close one eye in bright sunlight and at times show a manifest exotropia.

Most cases of divergent comitant strabismus are due to disruption of binocular reflexes before they have become sufficiently consolidated, or to the fact that they have not been sufficiently developed, so that the fusion mechanism is not able to overcome the divergent misalignment at some or all distances.

If fusion is strong, exophoria results, and it is remarkable how strong the desire for fusion may be even in the presence of anatomic obstacles. Some patients may fuse at one distance and not at others, or they may fuse at times only to show a manifest deviation on other occasions.

Three groups of patients with exotropia and exophoria may be classified according to their measurements by prism and alternate cover test. This classification will not include patients with consecutive exotropia.

Group I includes those patients whose measurements at near and distance were equal; Group II patients measured greater at near than at distance; and Group III patients measured greater at distance than at near.

Patients in Group I, with equal measurements at distance and near, have a normal accommodation-convergence ratio. Those in Groups II and III have an abnormal accommodation-convergence ratio.

Group III, which is the group I shall discuss, may be divided again into two groups. Patients in Group A have a nonaccommodative anomaly at near; patients in Group B have an abnormal accommodation-convergence ratio. The patients in Groups A and B may be myopic, emmetropic or hyperopic.

Accommodation provides one with clear vision. It is innate to want to see clearly. Under normal conditions each accommodative effort is accompanied by its proportional amount of convergence, and by the same token, convergence is accompanied by its proportional amount of accommodation. The close relationship between the two is approximately in a one-to-one ratio. The diopter is the unit of measure for accommodation, and the meter angle, the measure of convergence. At 6 meters the person with emmetropia does not accommodate; at 1 meter he accommodates 1 diopter; at 0.5 meter he accommodates 2 diopters; and at 0.33 meter, 3 diopters. This relationship between accommodation and convergence is not a rigid one and sometimes becomes upset. By the rule of one diopter of accommodation to one meter angle of convergence an exotropic patient with a normal accommodation-convergence ratio will have the same measurements for 6 meters and 33 cm. The exotropic patient with an abnormal accommodation-convergence ratio will have a greater divergence for one or the other.

It is necessary to have the refractive error determined under full cycloplegia, and very helpful to have prism and cover measurements with full correction under cycloplegia, at 6 meters and 33 cm.

To determine the basic deviation, full correction should be worn by the patient in a trial frame. A prism and alternate cover measurement is made with this correction to control accommodation, and bring out the greatest deviation. For near measurement, a plus three lens is added to this correction. If the deviation at near exceeds or equals the deviation at distance, this patient has an abnormal accommodation-convergence ratio. If the deviation at near is not increased when measured in this manner, the patient may have a nonaccommodative anomaly at near.

In testing the patient for fusion with the cover-uncover test with glasses, a 20/20 letter is used for the target while the technician observes the patient's eyes. If the basic deviation is, for example, 30 prism diopters of exotropia, the patient must converge 30 diopters in order to straighten his eyes. Because of the accommodation-convergence relationship, he will over-accommodate and the letter will be blurred. In order to see clearly, some of this excessive accommodation must be inhibited; convergence will also be inhibited; and exotropia results.

In absolute fusional vergence amplitudes, accommodation is not controlled. The absolute fusional vergence amplitudes are measured with prisms when the patient is not accommodating. The fixation target may be a light. Stronger and stronger prisms are placed base out before his eyes until diplopia results. The strongest prism that can be overcome with fusion while fixating a light at distance is the measure of prism convergence. Prisms are used base in in a similar manner to measure divergence. The end point is diplopia.

Relative fusional vergence is that amount of vergence which can be applied without changing accommodation. In relative amplitudes, the end point is blurred vision or diplopia. Relative convergence is that amount of convergence that can be exerted while accommodation is kept constant, and may be determined by base-out prisms.

In determining the near point of convergence, a target is brought toward the eyes, and the distance from the eyes where binocular vision breaks is measured. The examiner can determine this point objectively by observing the patient's eyes. By using a light as a fixation target, and placing a red filter over the dominant eye, the presence or absence of suppression can be noted as the near point is determined subjectively. If the patient is not suppressing, he will fuse and see a mixed red and white light. The light is carried slowly toward the eyes, and the distance at which he reports diplopia is measured. Usually the objective near point of convergence is closer than the subjective one.

The determination of both objective and subjective near points is valuable in prognosis as well as diagnosis. As a rule if the patient's subjective and objective near points are good, he may have limited fusional amplitudes but will respond well to treatment. But if his objective near point is good and the subjective one poor, his fusional amplitude will likely be poor, and he will complain of symptoms. The objective near point can be improved quickly since he can soon learn to converge his eyes. The subjective one improves more slowly, and as the patient makes

more progress in fusional amplitudes on the troposcope and prism bar, the subjective near point also improves. In testing fusional vergence on the troposcope and the prism bar, the blur point, the point where fusion breaks, and the point at which fusion is recovered are important. The blur point indicates that the limit of accommodational convergence has been reached; the break point indicates the outer limit of fusional vergence; and the recovery point, the patient's ability to overcome diplopia with vergence movement of the eyes.

Normal correspondence must be present or established before any further treatment is started. Good fixation of the deviating eye is very important.

If the patient is amblyopic, a well organized program for treating the amblyopia should be started at once and maintained until the vision in the poorer eye has reached its best level. While the better eye is occluded, many things may be done to improve vision in the ambloypic eye. Stringing very small beads in an orderly sequence, coloring to stay within line, playing games that require good vision, as dominoes, card games, etc., are helpful. After the vision has reached a fair level, but is not completely corrected, several types of partial occlusion may be put in a glasses frame over the better eye if correction is not worn.

An excellent way to overcome foveal suppression is to use foveal first grade targets on the troposcope, until bifoveal fixation is established. As soon as bifoveal fixation can be maintained on the troposcope, foveal fusion targets are used, and developing of vergence amplitudes begun. Foveal fusion should be established at the objective angle of deviation, and fusional range developed between this angle and zero. Then fusional convergence is developed on the positive side of zero.

Physiologic diplopia is invaluable in stablizing fusion in daily use of the eyes, and is one of the finest tools to be employed in fusion training. There are many exercises which employ its use, such as framing at all distances, and bar reading.

When the patient has normal secure physiologic diplopia at all distances, and bifoveal fixation on the troposcope, relative and absolute amplitudes are begun. Since relative fusional divergence and relative fusional convergence make single binocular vision possible, their importance cannot be stressed too much. I try to establish a relative divergence of 10 to 20 prism diopters, and a relative convergence of 30 diopters. This is attained by reading for near with prisms base out and base in, recession exercises from a vision chart while reading smaller and smaller letters on each trip as progress is made, until the patient can read 20/30 letters or numbers with clear binocular vision at 6 meters and 33 cm. with prisms base in and base out. A card with increasingly small numbers may be used at near for bar framing and reading. The patient bar frames the three middle numbers, reading always from the center and adding a number on each end each trip. He reads from the center to the right one time, and from center to left the next.

Walraven's bar separator is excellent for developing relative fusional divergence. The patient may use small letters or numbers starting from the center fusion area, and reading them in the same manner as the numbers. When the patient goes out of the center fusion area between the bars into the area where he reads through a bar, he is exercising relative

fusional divergence. Her card with the A's is fine, and as improvement is made, smaller print may be used. Bar reading on this instrument is an excellent exercise for stabilizing and improving fusion. A diplopia reader designed by Tibbs is especially effective for accommodative squints. It can be used by those patients who have weak fusion, and must work gradually down to bifoveal fixation.

Many exophoric patients, although fusing at near, report symptoms which may be explained by what Percival has called the area of comfort. As Duke-Elder states: "If comfort is to be maintained with close work, the positive portion of the relative convergence should be larger than the negative, so that there is ample converging power in reserve." It is generally true that patients are able to exercise only the middle third of their relative convergence for any particular distance of work (that is for any fixed amount of accommodation) if they are not to become liable to visual fatigue. This middle third Percival has called the area of comfort.

If a person has to go outside this limit in his work either in a positive or a negative direction, he should either receive treatment by vergence exercises or relief by prisms or a mechanical adjustment should be made by operation. So far as the working distance is concerned, these considerations are more productive of discomfort and more important clinically than absolute deficiency of convergence.

More than one third of the total convergence cannot be used for any length of time without fatigue. Thus, if at 33 cm. a patient can tolerate abducting prisms of 4 diopters, and adducting prisms of 8 diopters, the convergence at the working distance just comes within the area of comfort. But if he can abduct 2 diopters, and adduct 10 diopters, he will not be comfortable since the area of comfort lies outside of this area. Although the absolute range of relative convergence is the same for the two patients, the second will suffer from symptoms of convergence excess (relative esophoria) and will require relief to compensate for 2 diopters. The ratio is one to three, as minus four and plus eight, making the area of comfort lie in the positive portion.

Some of these patients at times show fusion at all distances, and read 20/30 print at near with binocular vision, but on occasion become exotropic when reading the vision chart at distance. They must learn to inhibit accommodation while exerting convergence. The amount of convergence called for to bring the visual axes to parallelism also calls for an excess of accommodation. In order to see clearly, the accommodation must be inhibited, which causes convergence to be inhibited, and the result is exotropia. We have the patient diverge and appreciate diplopia on a lighted vision chart at 6 meters with clear vision; reading a line on first one chart then the other; then straighten with blurred vision, and diverge to read the next line and so on down the chart until he can read with clear single binocular vision the 20/20 line. This is called locking accommodation. Accommodation is inhibited while convergence is exerted.

When a bilateral recession of the lateral recti is done as a first stage of surgical treatment, a great many of these patients whose measurements are greater for 6 meters than for 33 cm. are within range at both distances to fuse and take care of any residual deviation. However, some eyes in both groups may cross at near. Non-

accommodative patients may require a later bilateral recession of the medial recti to correct this. However, we feel that it is best to try orthoptic training first; some eyes may straighten without operation or require less extensive surgical treatment.

When the patient's accommodation-convergence ratio is abnormal and he is esotropic at near after operation, accommodation and convergence must be dissociated. He has an accommodative problem, and he may be treated as an accommodative esotrope when dissociating accommodation and convergence at near. A bifocal with plano top segment is prescribed and should be only as strong as will hold his eyes straight when reading a 20/30 letter at 33 cm. As bifoveal fixation is secure, and fusional amplitudes increase, and the patient has binocular single vision when reading a 20/30 letter at near with minus lenses before the bifocal, clip-ons of this strength are given him to wear while doing near work. When this is secure, stronger and stronger minus lenses are given him to wear over his glasses until the glasses are off, and his eyes are straight. Then, in order to have reserve positive relative accommodation, minus lenses are used while working on the troposcope and for bar reading until he can accept as much minus power as the strength of his cycloplegic finding, if it is not too great. If possible he should accept -1.50 beyond this with clear binocular vision. Fortunately, surgical overcorrection of divergent strabismus is relatively infrequent.

AMERICAN ORTHOPTIC JOURNAL

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BASIC COURSE IN ORTHOPTICS TO BE CONTINUED

During the summer of 1958 the basic course in orthoptics sponsored by the American Orthoptic Council was given for the first time in Ann Arbor. Prior locations within recent years had been at Washington University in St. Louis, and at the University of Iowa. It was possible to organize the course in 1958 as a regular summer session course of the University of Michigan, allowing the registrants the full advantages of student enrollment in the University. This included facilities of the Student Health Service, the Women's League, and the women's athletic facilities, including the use of the swimming pool. Individual counselling, as necessary, was carried out by representatives of the office of the Dean of Women. Housing was arranged in dormitory facilities adjacent to University Hospital, where the lectures were held. Twenty students were registered for the eight-week session, and all completed the course. Many of them are continuing with their ten-month practical training at the present time, and will be qualified for their examination in orthoptics for certification by the Council in 1959.

A large percentage of the class had more than the minimum educational background required by the Council for admission, and the lecturers were unanimous in their reaction that the task of teaching was lightened considerably by this factor. It appears evident that a more rigid adherence to preliminary education will attract better candidates for orthoptics, and better information must be placed in

the hands of vocational advisors in order to continue an adequate flow of students. During the past year orthoptic training has been listed in several fundamental publications for vocational counsellors, and the number of inquiries for the Council brochure has been increasing steadily.

The problem of the type of course to be given still has not been solved, however, since there are generally two groups of students taking the basic instruction. The first are those to whom orthoptics is an entirely new subject, and for these much preliminary teaching of nomenclature and basic concepts is necessary. The second group comprises those students who have already begun orthoptics in some center, and who come to the summer course to study the basic material more thoroughly. With the number of registrants taking the course at present, it is impossible to present two separate courses; but if growth in numbers of students occurs in the future, the Council should consider seriously the possibility of presenting both a fundamental course for beginners and a second one for those with a greater background.

Plans are now under way for presentation of the Basic Course in Orthoptics to be held at the University of Michigan during the summer session from June 22 through August 15. The lectures will be held at the University Hospital, housing will be provided in the University dormitories, and practical demonstrations will be arranged, again utilizing facilities in Detroit.

For further information with regard to the course, please contact John W. Henderson, M.D., Room 6155, Outpatient Building, University Medical Center, Ann Arbor, Michigan.

JOHN W. HENDERSON, M.D.

PLEOPTICS

During the past few years the interest in the problem of strabismic amblyopia has become both wider and deeper. By various, in part rather elaborate, measures, investigations into the nature of amblyopia have been carried out and attention has turned to a number of the unusual features of this most interesting form of functional reduction in visual acuity. The fixation pattern of amblyopic eyes has been studied by subjective procedures (afterimages) and objective procedures (electro-ophthalmography). The puzzling fact that an amblyopic eye may have a rather high visual acuity when tested with isolated symbols, whereas the vision is considerably reduced when the symbols are presented in a row, is as yet not fully explained. The cases of amblyopia which are most difficult to handle, those with eccentric fixation, have undergone intensive study, particularly in some European centers.

The great amount of work expended on the solution of the amblyopia problem cannot fail to result eventually in an improved understanding of the condition and in an improvement of our therapeutic procedures. It behooves both the ophthalmologists and the orthoptists to become acquainted with the new thoughts and methods in this field, and the American Orthoptic Council has therefore decided that the next Joint Meeting of the American Orthoptic Council and of the Association of American Orthoptic Technicians in October 1959, to be held as is customary in conjunction with the meeting of the American Academy of Ophthalmology and Otolaryngology, shall be devoted to a symposium on pleoptics. It is to be expected that the presentations will

prove of considerable interest to everyone, both in regard to the theory of amblyopia and to the first results obtained with the new forms of treatment, originated in Europe, as applied to the conditions prevailing in the United States.

HERMANN M. BURIAN, M.D.

THE RESPONSIBILITY OF LEARNING

A study of history will reveal that no one is always all that he should be. The ideal person and the real person are often distressingly different, a difference which may seem more apparent in the medical profession than in other fields of endeavor. Patients tend to look upon their physicians (and their ancillary workers) as being infallible and to notice quickly when they are not.

The ideal ophthalmologist is one who always make the correct diagnosis without delay and who cures the patient with a few days' treatment or a (simple) operation without fanfare. Usually, he sends no bill because it was a privilege to care for such an interesting case. If the patient presents a motility problem requiring the services of an orthoptic technician, she promptly restores binocularity by means of a few easy exercises and thus eradicates the effects of months of delay.

To point out the many sharp differences between the ideal and the actual is impossible in this short editorial. We cannot always make a diagnostic decision quickly nor can we always make it correctly. Neither can we always obtain the perfect cure. We can, however, always do our best and always strive to do better. We can avoid complacency.

It is the responsibility of all of us to want to be better doctors and better orthoptic technicians. Failure to take advantage of all the opportunities available to us for increasing our knowledge is inexcusable. When we graduated from medical school we thought we knew all there was to know about the practice of medicine, but it took only a few weeks of internship for us to realize that this was not so. We know now that one never learns everything and that the search for further knowledge is never-ending. We must all continue to learn.

EDMUND L. COOPER, M.D.

THE AMERICAN ASSOCIATION OF ORTHOPTIC TECHNICIANS IN ITS SEVENTEENTH YEAR

The Association has shown continued growth. In this, our seventeenth year, we are proud to note that we have members in Europe as well as in Canada and Latin America.

Members will have received detailed minutes of the 1958 meeting, but I will mention certain of our services which may be of interest.

There is an Outside Exhibit Committee which this year placed an orthoptic exhibit at the Sight Saving Convention in Philadelphia. Such exhibits are available for meetings of pediatric societies or any other group whose members might be interested in learning more about what orthoptics training does and can do.

The Confidential Placement Service is putting orthoptists seeking a change of employeemnt in touch with ophthalmologists wishing the services of

an orthoptist. Both ophthalmologists and orthoptists are urged to make use of the placement service. The present chairmen of these committees are listed in this Journal.

The Lancaster award, the greatest honor that can be given to any of us, was presented this year to Elsie Laughlin for outstanding achievement in orthoptics. She joins a small and honored group of past recipients, namely, Julia Lancaster, Elizabeth Stark (who retires this year), Frances Walraven, Elizabeth Jackson and Louisa Kramer.

Standards of examination and for acceptance of students have been raised, and greater efforts are being made to attract suitable students and to inform colleges and universities of the opportunities in a career in orthoptics. These are good signs, showing that we are not static, but changing and growing.

The American Orthoptic Council has done a magnificent job in initiating and guiding our efforts both professionally and ethically. We are grateful.

FRANCES FOWLER

TECHNICIANS AS COMPETENT ASSISTANTS

The American Association of Orthoptic Technicians serves an important function in establishing and maintaining standards of practice and a code of ethics for the members of this society.

No professional man can accomplish much without expert assistants. The architect must have his draftsmen; the attorney, his accountants; the orthopedic surgeon, his physiotherapists, and the ophthalmologist, his orthoptists. The caliber of the professional man's work depends on the competence of his assistants. The doctor of medicine obviously would be in trouble if his biochemist did not properly determine the amount of sugar in the blood of a diabetic patient; the cardiologist would be misled by an unreliable electrocardiogram.

The training and dependability of the orthoptist is of prime importance to the ophthalmologist in the diagnosis, as well as treatment, of patients with eye muscle problems.

S. RODMAN IRVINE, M.D.

ORTHOPTIC INSTRUCTION COURSES

Eight instruction courses for Orthoptic Technicians, sponsored by the American Orthoptic Council through its Committee on Instruction, will be presented this year by the American Academy of Ophthalmology and Otolaryngology. They will be given Monday and Tuesday mornings, October 12 and 13, during the annual session of the Academy. Tickets will be on sale at the Registration Desk. Price of tickets will be $2 for each one-hour course.

Course OT1

Room 786 — Periods M-1 & M-2
or
Room 786 — Periods T-2 & T-3

MARSHALL M. PARKS, M.D.
Washington, D. C.

ALEATHA J. TIBBS
Atlanta, Georgia

Physiology of Accommodation and Convergence
Treatment of Accommodative Strabismus

Course OT2

Room 784 — Period M-1 or T-1

PAUL BOEDER, Ph.D.
Iowa City, Iowa

Optics for the Orthoptist

Course OT3

Room 784 — Period M-3 or T-2

FLETCHER WOODWARD, JR.
Fort Lauderdale, Florida

Treatment of Abnormal Retinal Correspondence

Course OT4

Room 795 — Period M-3 or T-3

CHARLES F. COOPER, JR.
Atlanta, Georgia

A and V Syndromes

Course OT5

Room 795 — Period M-1 or T-1

SALLY MOORE
New York, New York

Antisuppression Techniques and Development of Absolute and Relative Vergences

---

Course OT6

Room 784 or 786 — Period M-2 or T-1

MARY C. FLETCHER, M.D.
Houston, Texas

Role of Orthoptics in Preoperative and Postoperative Squints in the Young Child

---

Course OT7

Room 786 or 784 — Period M-3 or T-3

DOROTHY BAIR
Washington, D. C.

Methods of Diagnosis of Motor and Sensory Anomalies in Squint

---

Course OT8

Room 795 — Period M-2 or T-2

SAMUEL C. McLAUGHLIN
Ann Arbor, Michigan

New Method of Treatment in Strabismus

AMERICAN ORTHOPTIC COUNCIL — 1959

The American Orthoptic Council is composed of three representatives each from the American Ophthalmological Society, the Section on Ophthalmology of the American Medical Association, the American Academy of Ophthalmology and Otolaryngology, and the American College of Surgeons. Three members are elected from the American Association of Orthoptic Technicians. The President of the American Association of Orthoptic Technicians also sits on the Council as an ex-officio member.

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Chairman—Miss Julie Jacino

Eastern—Portland, Maine
Chairman—Mrs. Jane Hall

Southern—Little Rock, Arkansas
Chairman—Miss Mary Wackerhagen

Midwestern—Indianapolis, Indiana
Chairman—Miss Nina Pick

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Confidential Placement Service: Miss Margaret Crush, Director

Program: Miss Eleanor Anderson, chairman; Miss Frances Fowler

Instructions: Miss Dorothy Stobie, chairman; Mrs. Audrey Gould; Mrs. Ellen Greer; Miss Catherine Lunn; Miss Elizabeth Goggin; Miss Aleatha Tibbs

Academy Exhibit: Miss Eva DeMars, chairman

Other Exhibits: Miss Evelyn Taylor, chairman; (committees appointed as needed)

Lancaster Award: Miss Elizabeth Stark, chairman; Miss Elizabeth Jackson; Mrs. Louisa Kramer; Miss Frances Walraven; Mrs. Elsie Laughlin

By-Laws: Miss Frances Walraven, chairman; Miss Elizabeth Jackson; Miss Ruth Fisher

Public Relations: Miss Mary Hempstead, chairman; Miss Geraldine Wood; Miss Patricia O'Neil

Hardy Memorial: Miss Elizabeth Stark, chairman

ABSTRACTS OF OPHTHALMIC LITERATURE

The section on abstracts was made possible by the able assistance of Sally Moore, associate editor, Mary Wackerhagen, assistant editor, Velma Ritter, assistant editor, and a committee consisting of Olympia Bakas, Julia Jacino, and Bobbie Davis.

Berens, Conrad: *Visual acuity and color recognition test for children*, Am. J. Ophth., 46:219 (Aug.) 1958.

Berens describes his test for determining visual acuity of children younger than four years. He also uses the test to ascertain the ability of older children to identify colors.

Berens, Conrad; Brackett, Vivian, and Taylor, B. Evelyn: *Diverging exercises while accommodating*, A.M.A. Arch. Ophth., 59:24-28 (Jan.) 1958.

The authors present a method of teaching patients diverging exercises while accommodating. Two case reports are cited showing excellent functional results.

The equipment consists of a horizontal prism rack, an accommodation card with letters, numbers, and single E's graduated in size. There are also plus and minus spheres and prisms in clip-on frames.

Breinin, Goodwin M.: *The nature of vergence revealed by electromyography. II. Accommodative and fusional vergence*, A.M.A. Arch. of Ophth., 58:623-631 (Nov.) 1957.

Various lenses were used on normal subjects, and a "basic uniformity in the motor response of the extraocular muscles" was determined. Breinin shows that "fusion training is a central phenomenon, which does not result in greater muscle power."

Carbajal, Ulysses M.: *An analysis of 142 cases of ptosis*, Am. J. Ophth., 45:692-704 (May) 1958.

Ptosis may be congenital or acquired, unilateral or bilateral. Carbajal discusses these types and mentions sex distribution. He enumerates complications encountered in the surgical management of ptosis and methods of preventing complications.

A modified classification of congenital ptosis is offered to help the surgeon to decide which ptosis procedure to use. The causative factors in congenital ptosis are discussed.

Costenbader, Frank D., and Albert, Dan G.: *Spontaneous regression of pseudoparalysis of the inferior oblique muscle*, A.M.A. Arch. Ophth., 59:607-608 (April) 1958.

A case of pseudoparalysis of the inferior oblique muscle that disappeared spontaneously is here reported. A child was examined three times between 3 and 6 years of age showing repeated complete inabiltity to elevate the left eye in the nasal field. When examined 6 months later, however, this apparent paralysis of the inferior oblique had completely disappeared. Speculation as to the pathogenesis is given.

Efron, Robert: *Stereoscopic vision. I. Effect of binocular temporal summation*, Brit. J. Ophth., 41:709-730 (Dec.) 1957.

Efron discusses his experiment concerning stereoscopic vision. Some of the factors included are time interval, visual stimuli and variability of amount of stimuli.

Efron states: "The original purpose of this experiment was to show that stereoscopic vision or binocular fusion results from alternating 'attention' by the brain to the two retinal images from the two eyes . . . .

"The experiment has shown that the temporal summation . . . exists in a similar form for such 'higher' or more complex integrative actions of the nervous system as stereoscopic fusion."

Fink, Walter H.: *An anatomic study of the check mechanism of the vertical muscles of the eyes*, Am. J. Ophth., 44:800-809 (Dec.) 1957.

Fink states that the knowledge of the check mechanism of the horizontal muscles of the eyes is fairly well established, but very little positive evidence of the check mechanism of the vertical muscles is available.

He reviews the anatomy of the fascial membranes associated with vertical muscles, and the role of these membranes in the check mechanism.

Girard, Louis J., and Neely, Robert A.: *Agenesis of the medial rectus muscle*, A.M.A. Arch. Ophth., 59: 337-341 (March) 1958.

The authors state in their summary: "A case of Agenesis of the medial rectus muscle with inability to adduct the eye past the midline is presented. This deficiency was corrected by transplantation of slips from the vertical recti, and, as a result, the patient could fuse in the primary position and adduct the affected eye.

"The case is discussed from three physiologic aspects which are of interest: (1) ability to perform some adduction in the absence of the medial rotator, (2) improved adduction after transplantation of slips from the vertical recti, and (3) the possibility of iris necrosis and iridocyclitis after surgery involving all four rectus muscles."

Jampolsky, Arthur: *Bilateral anomalies of the oblique muscles*, Tr. Am. Acad. Ophth., 61:689-700 (Nov.-Dec.) 1957.

This study points out the involvement of the obliques secondary to monocular exotropia in which there is an overaction of both the superior and inferior oblique muscles. The second portion of the paper deals with the effect of bilateral oblique anomalies upon the horizontal deviation, including variations in the horizontal deviation in the straight up and straight down positions. Jampolsky discusses the management of these patients requiring symmetrical oblique surgery and the results that may be expected as relates to the horizontal component of the deviation.

Mayweg, S., and Massie, H. H.: *Amblyopia ex anopsia* (*suppresssion amblyopia*) Brit. J. Ophth., 42:257-269 (May) 1958.

Using Cüppers' methods and instruments including the visuscope, euthyscope and coordinator, the authors treated 50 patients with amblyopia who had failed to respond to conventional occlusion of the fixing eye. Visual acuity was tested both for distance and near, and more reliance was placed on the "cortical acuity" in reading a whole line of test type, than on the "angular acuity" where the individual letter was isolated. Results were considered encouraging with 38 patients improving to 6/12 and N. 10 or better.

Parks, Marshall M.: *Abnormal accommodative convergence in squint.* A.M.A. Arch. Ophth., 59:364-380 (March) 1958.

The study concerns a series of cases, divided into three parts. The first shows the differences and similarities in onset age and ametropia between stabismic groups having a normal accommodation and accommodation-convergence ratio (A:AC) and those having abnormal A:AC. The second presents the results of attempts to alter abnormal A:AC in strabismus. The third gives results of attempts to increase the relative fusional divergence in esotropes that have a normal A:AC.

Factors discussed include congenital and acquired esotropia, bifocals, D.F.P., orthoptics and surgery.

Pugh, Mary: *Visual distortion in amblyopia*, Brit. J. Ophth., 42:449-460 (Aug.) 1958.

Visual acuity of an amblyopic eye appears worse when checked with a whole line of Snellen letters than with isolated letters. Difficulty in reading a series of letters with an amblyopic eye is due to the effect of one letter overlapping another. Amblyopic patients have trouble "disentangling" letters. Patients show a specific pattern of blurring or distortion involving the right or left side of each character. Direction of distortion may bear a specific relationship to the direction of the heterotropia, and is usually opposite to it.

Reed, Howard, and Grant, Wallace: *Möbius's syndrome, Brit. J. Ophth.*, 41:731-740 (Dec.) 1957.

The authors report three more cases of this rare condition and note the absence of any association with Rh incompatibility. They suggest the clue to the cause may lie in more detailed investigation of pregnancy histories.

Rucker, C. Wilbur: *Paralysis of the third, fourth and sixth cranial nerves*, Am. J. Ophth., 46:787-794 (Dec.) 1958.

Review of 1,000 cases of eye muscle paralysis found the cause undetermined in 28 per cent. About 17 per cent were due to head injuries and another 17 per cent to brain

tumors. Vascular disease explained 15 per cent. Aneurysm of the circle of Willis explained paralysis in 11 per cent, the majority of these involving the third nerve. A remaining 12 per cent were due to miscellaneous causes.

Sabin, Fred C., and Ogle, Kenneth N.: *Accommodation-convergence association. Experiments with phenylephrine, pilocarpine, and physostigmine*, A.M.A. Arch. Ophth., 59: 324-332 (March) 1958.

Recent data have shown that the amount of convergence which is associated with a given change in dioptric stimulus to accommodate increases somewhat when the eyes are under cycloplegia induced by homatropine as compared to their normal status. Homatropine causes an increase in accomodative convergence-accommodation ratio, that varies with the degree of cycloplegia. The problems that are studied show the effect of such drugs as pilocarpine and physostigmine on the accommodative convergence All the data gathered by the authors were obtained by the fixation-disparity technique.

Results show that phenylephrine (Neo-Synephrine), which dilates the pupils yet has little effect on the accommodation, caused no change in accommodative convergence within appreciable measurement. Although the linear relationship between accommodative convergence and the change in stimulus to accommodation was maintained, there seemed to be no significant change from the average found without the drug. In two subjects, the effects of physostigmine and pilocarpine were essentially the same. The effect of these drugs is also studied in relationship to the size of the pupils in accommodative stimulus.

Sayoc, Burgos T.: *Exotropic retraction syndrome with congenital homolateral ptosis*, Am. J. Ophth., 44: 777-779 (Dec.) 1957.

Sayoc gives two case reports and states: "Descriptions of the retraction syndrome seem to associate the condition with convergence strabismus, whereas in my experience . . . it is associated with divergence strabismus and is accompanied by congenital homolateral ptosis."

Stanworth, A.: *Modified major amblyoscope*, Brit. J. Ophth., 42:270-287 (May) 1958.

A modified major amblyoscope is described in which measurements are made in a manner similar to the one used with the routine instrument, but in which the conditions for the patient approximate those of everyday life. The change-over from routine to modified method of examination is rapid and easy.

The modified method makes possible an assessment of the angle of squint and the use made of the patient's binocular vision under normal conditions. It is also of particular value in the detection of abnormal retinal correspondence, in small-angle squints, and in patients in whom the cover test is difficult to interpret. The measurement of peripheral fusion in a patient with small-angle squints and of fixation disparity under normal viewing conditions is brought within the range of ordinary clinical practice.

Tour, Robert L., and Asbury, Taylor: *Overcorrection of esotropia following bilateral five-mm. medial rectus recession*, Am, J. Ophth., 46: 644-653 (May) 1958.

The authors consider the choice of operative procedure and whether unilateral or bilateral surgery should be done.

They believe that 4 mm. bilateral recessions of the medial recti are not as apt to cause overcorrections as are 5 mm. bilateral recessions. It may be noted, however, that two tables show that the average original deviation (17 cases) of 49.4 diopters has received a 4 mm. bilateral recession and the average original deviation (17 cases) of 42.6Δ had received a 5 mm. bilateral recession. It seems that an overcorrection of the latter would be more expected.

In spite of the numerous intangible factors resulting in wide variations in the outcome of muscle surgery in general, there are certain basic physiologic concepts which cannot be ignored. Their application may result in a considerably greater degree of predictability than is generally assumed.

Urist, Martin J.: *The etiology of so-called A and V syndromes*, Am. J. Ophth., 46:835-844 (Dec.) 1958.

The terms "A syndrome" and "V syndrome" have focused attention on the importance of the straight up and straight down

positions in motility examinations. These A and V deviations can be the result of dysfunction of the horizontal recti.

V-esotropia, with apparent overaction of the inferior obliques, may be due to overacting medial recti. V-exotropia, with apparent overaction of inferior obliques, may be due to overacting lateral recti.

A-esotropia, with apparent underaction of the inferior obliques, may be due to underacting lateral recti. A-exotropia, with apparent underaction of the inferior obliques, may be due to underacting medial recti.

Urist, Martin J.: *The effect of asymmetrical horizontal muscle surgery*, A.M.A. Arch. Ophth., 59:247-259 (Feb.) 1958.

The author illustrates with representative cases various types of asymmetrical horizontal surgery.

Urist feels that the results of his study are consistent with the physiology of action of the horizontal extraocular muscles. The medial rectus being an adductor, showed greater effect after surgery in adduction, or to the opposite side. Lateral rectus surgery had greatest effect to the same side.

When there was a combined operation on one side, such as a unilateral medial recession and a lateral resection or unilateral medial resection and lateral recession, the greatest effect of surgery was in the direction of action of the recessed muscle.

Wheeler, Maynard C.: *Punch cards for motility records*, A.M.A. Arch. Ophth., 59:603-606 (April) 1958.

A preliminary report of the use of punch cards for motility records is presented. Wheeler prefers three separate cards recording initial visit, surgical treatment and postoperative treatment. A code for punching holes is utilized to conserve space.

Witzel, S. H.: *Congenital paralysis of lateral conjugate gaze. Occurrence in a case of Klippel-Feil syndrome*, A.M.A. Arch Ophth., 59:463-464 (March) 1958.

Congenital conjugate gaze palsies are rare. Several have been reported but this one differs from the others in that this child had no facial paralysis and had fusion. With the exception of Bauman's patient, this is the first reported case, exhibiting as a congenital lesion, a total paralysis of conjugate lateral gaze in both directions, but with maintenance of convergence and fusion.

This case may present clinical evidence for the existence of a subcortical center for conjugate lateral gaze movements.

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